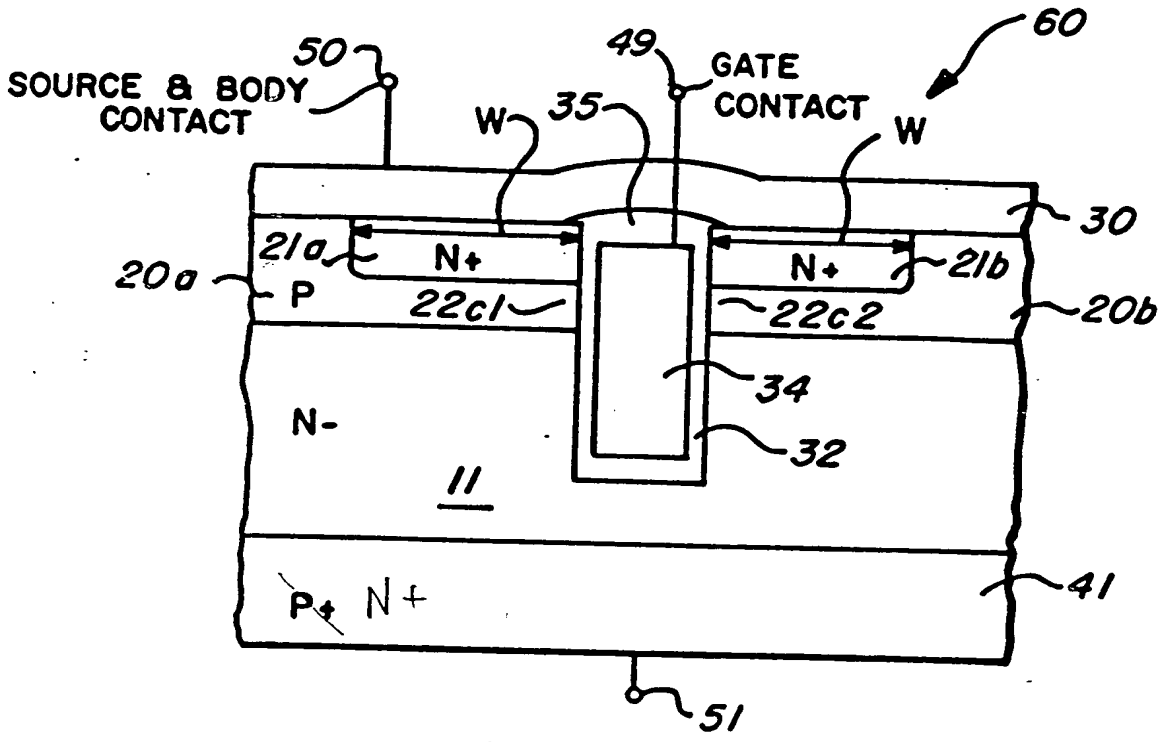


Figure 1

Cross-section of a trenched DMOS power transistor cell (prior art, /1,2/).

read & understood [signature] August 10, 1988

read and understood Randolph D. Mech August 11, 1988

08/185,608

~~08/086976~~

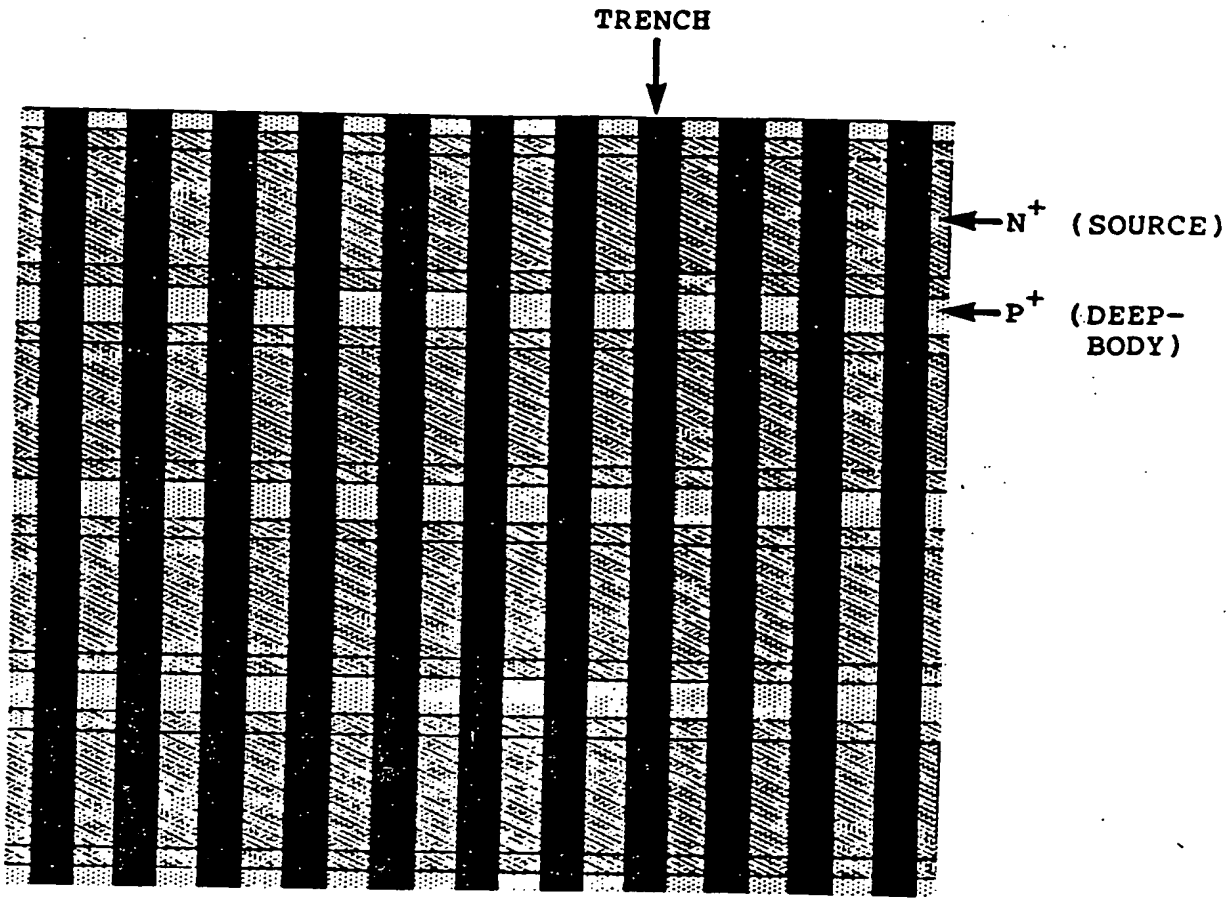


Figure 2,a

"Open-cell" implementation of a trenched DMOS power transistor (CALMA hard copy, active region). Siliconix, Inc., 1987.

read + understood August 10, 1988
read and understood August 11, 1988

08/185,608
~~07/086,976~~

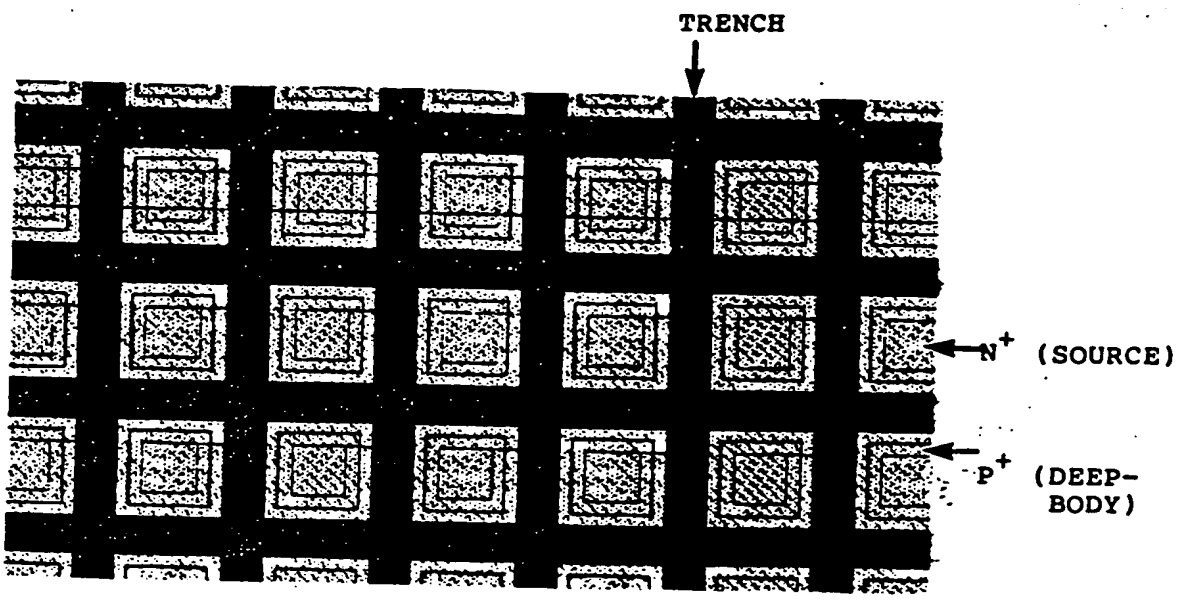


Figure 2,b

"Closed-cell" implementation of a trenched DMOS power transistor (CALMA hard copy, active region). Siliconix, Inc., 1987.

read + understood August 10, 1988
read and understood August 4, 1988

08/185/608
~~08/086976~~

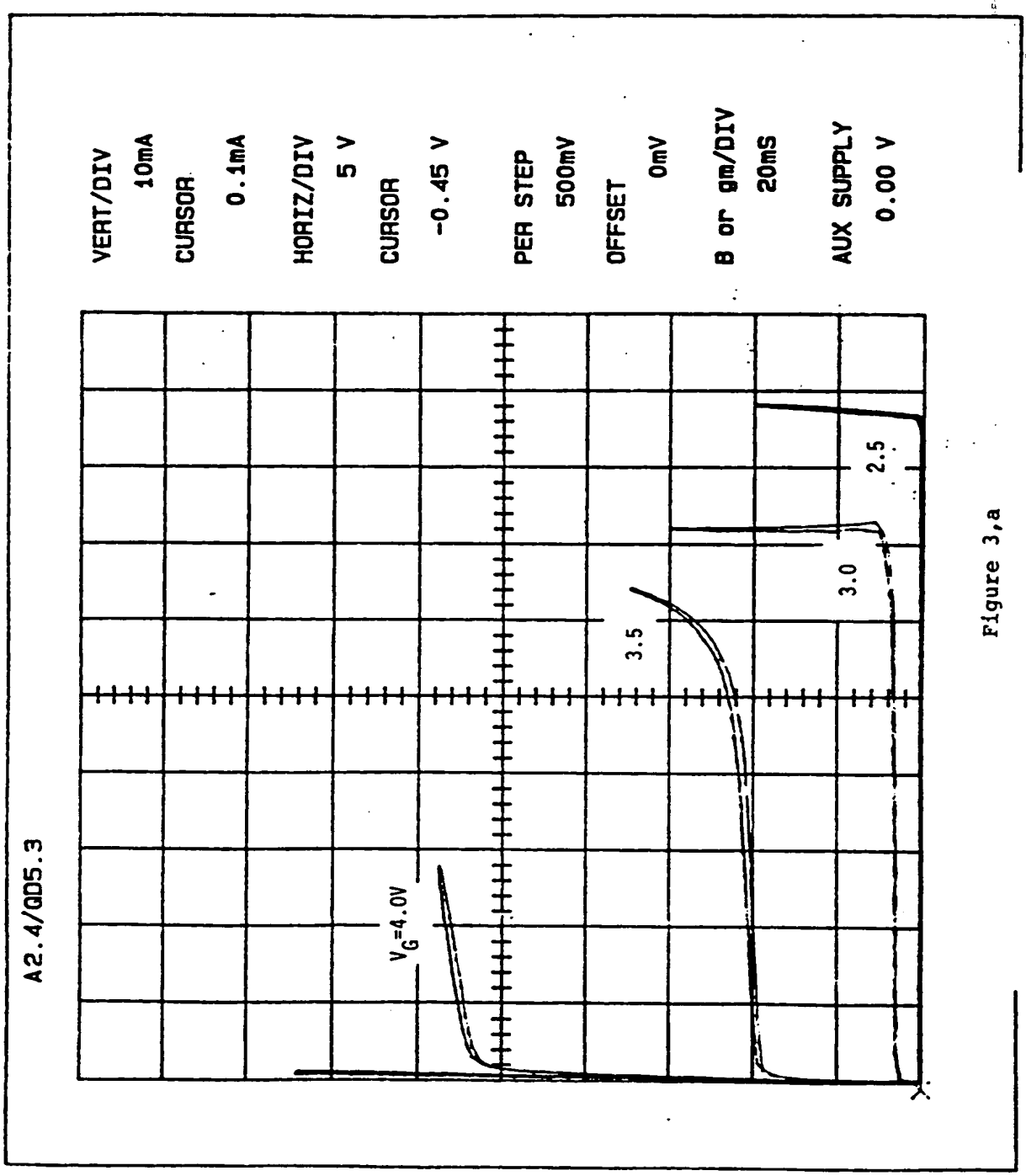


Figure 3,a

Output I-V characteristics of an experimental "open-cell" trenched DMOS transistor having distant body contacts, perpendicular to the trenches. Siliconix, Inc., 1988.

read & understood August 10, 1988
read and understood August 11, 1988 Randolph D. Nash

08/85/168

~~08/086976~~

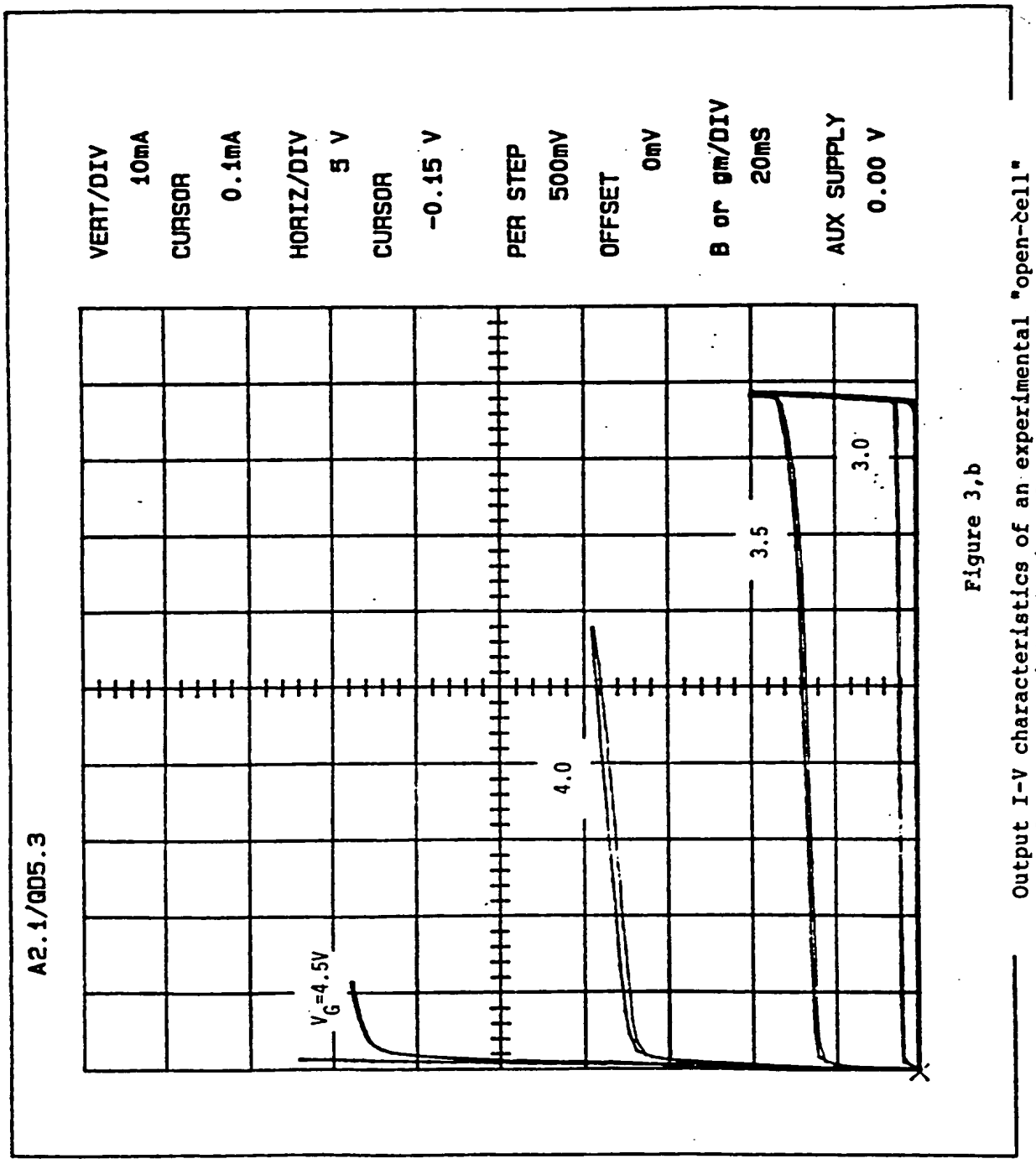


Figure 3,b

Output I-V characteristics of an experimental "open-cell" trenched DMOS transistor having closely-spaced body contacts, perpendicular to the trenches. Siliconix, Inc., 1988.

read & understood & KWH August 10, 1988
read and understood Randolph D. Lee August 11, 1988

08/851608

~~08/086976~~

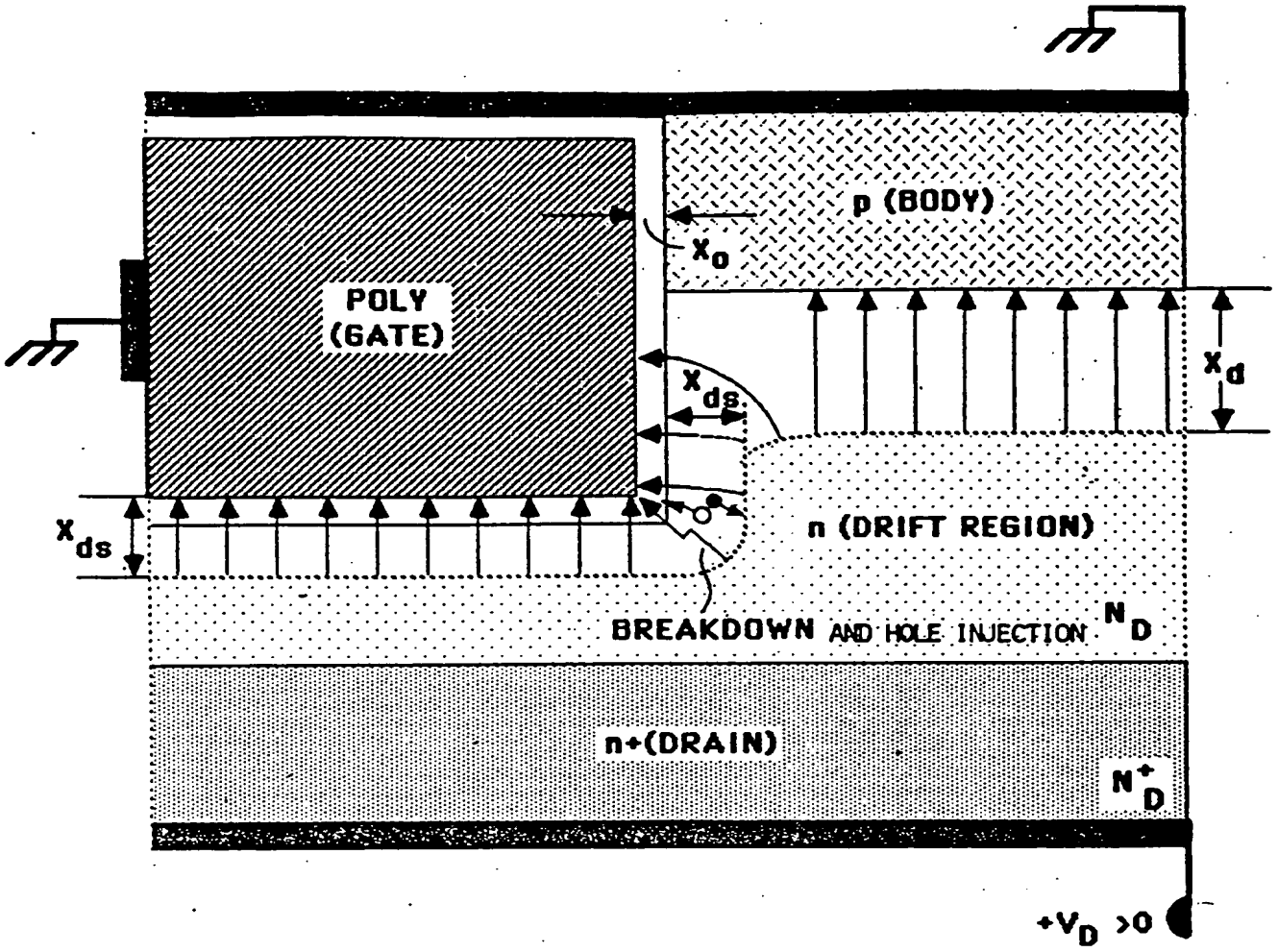


Figure 4

Qualitative description of the electric-field structure in a trenched DMOS transistor having no deep-body profile provision. BVDSS biasing, source junction omitted.

read & understood August 10, 1988

read and understood Rudolph D. August 11, 1988

08/185/1608

~~086976~~

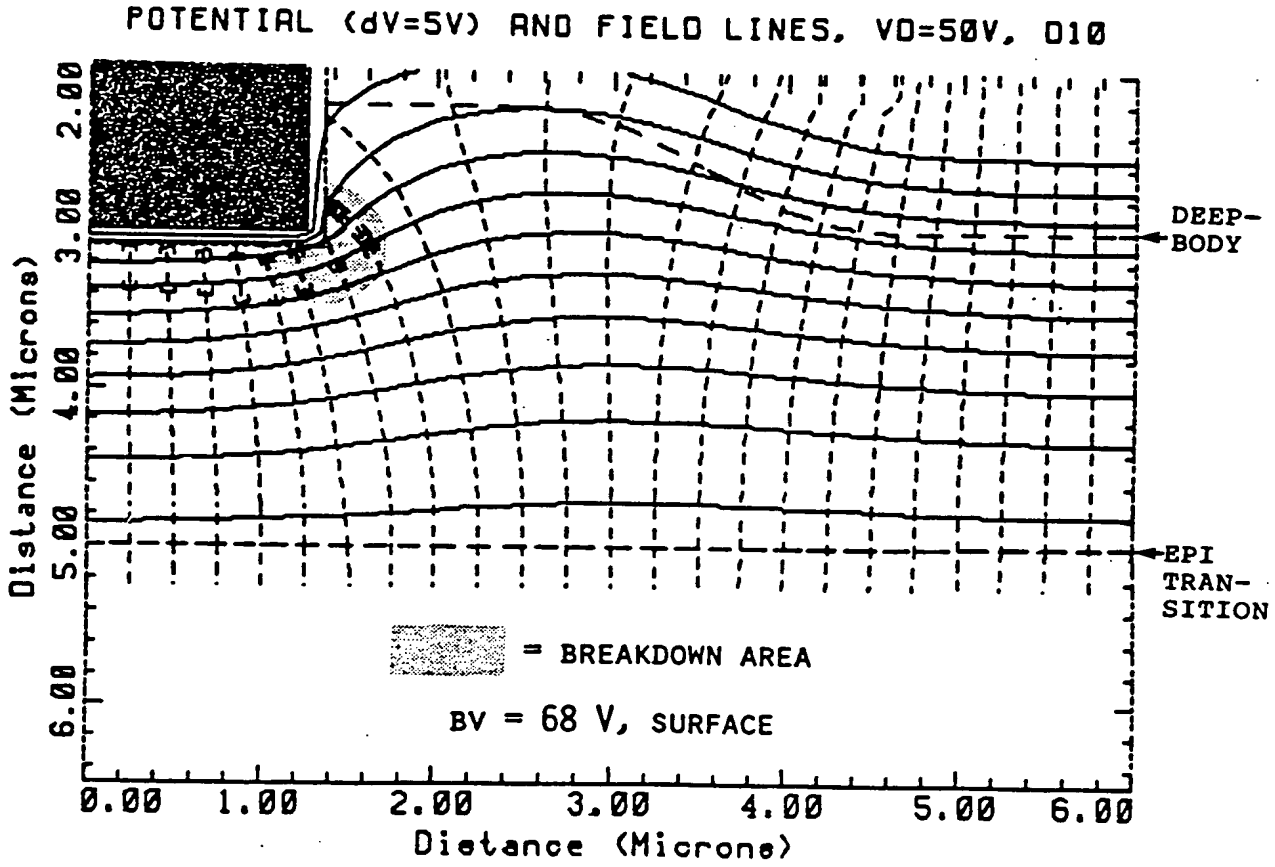


Figure 5

2-D computer simulation of the BVDSS operation of a trenched DMOS transistor having the deep body junction shallower than the trench. Drain breakdown takes place beneath the trench surface.

read & understood August 10, 1988

read & understood August 11, 1988

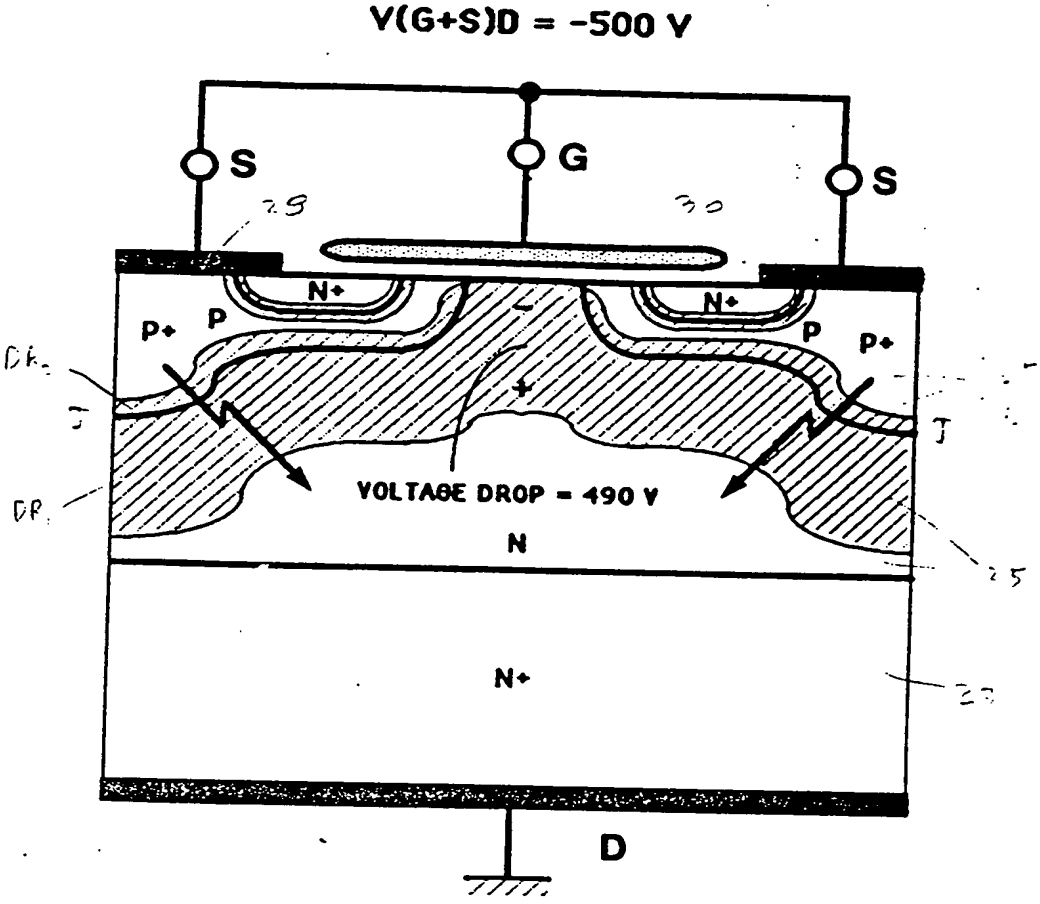


Figure 6

Junction and depletion-region topology
of a planar DMOS transistor biased in the BVDSS condition.

read + understood August 10, 1988
read & understood Rachel D. Id. August 11, 1988

2-D OXIDATION
SQUARE-CELL DESIGN

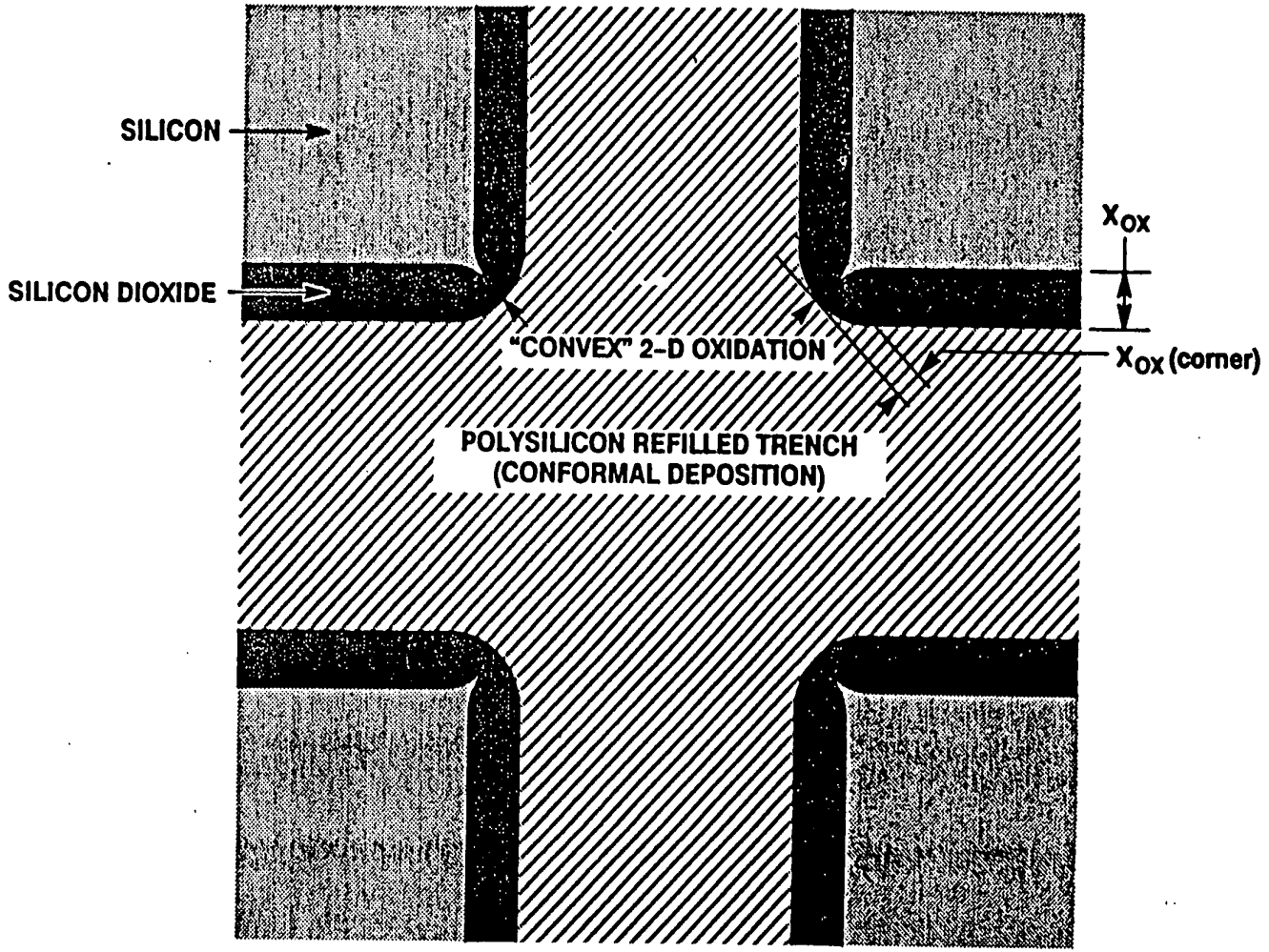


Figure 7

Qualitative description of the oxide profile at a rectangular trench intersection.

read + understood QKWA August 10, 1988
read and submitted Raleigh Duke August 4, 1988

081 65/608
~~#08809~~

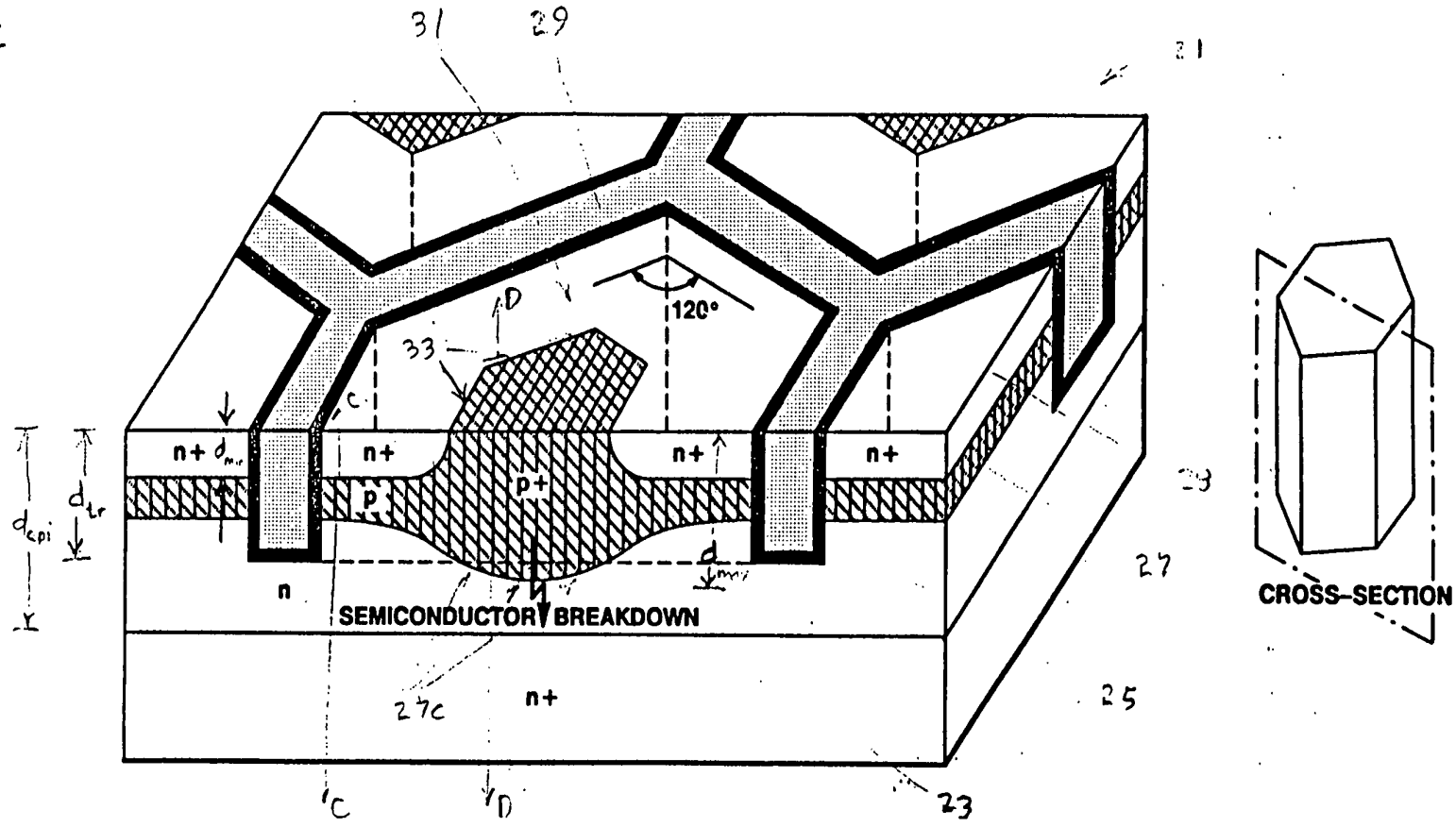
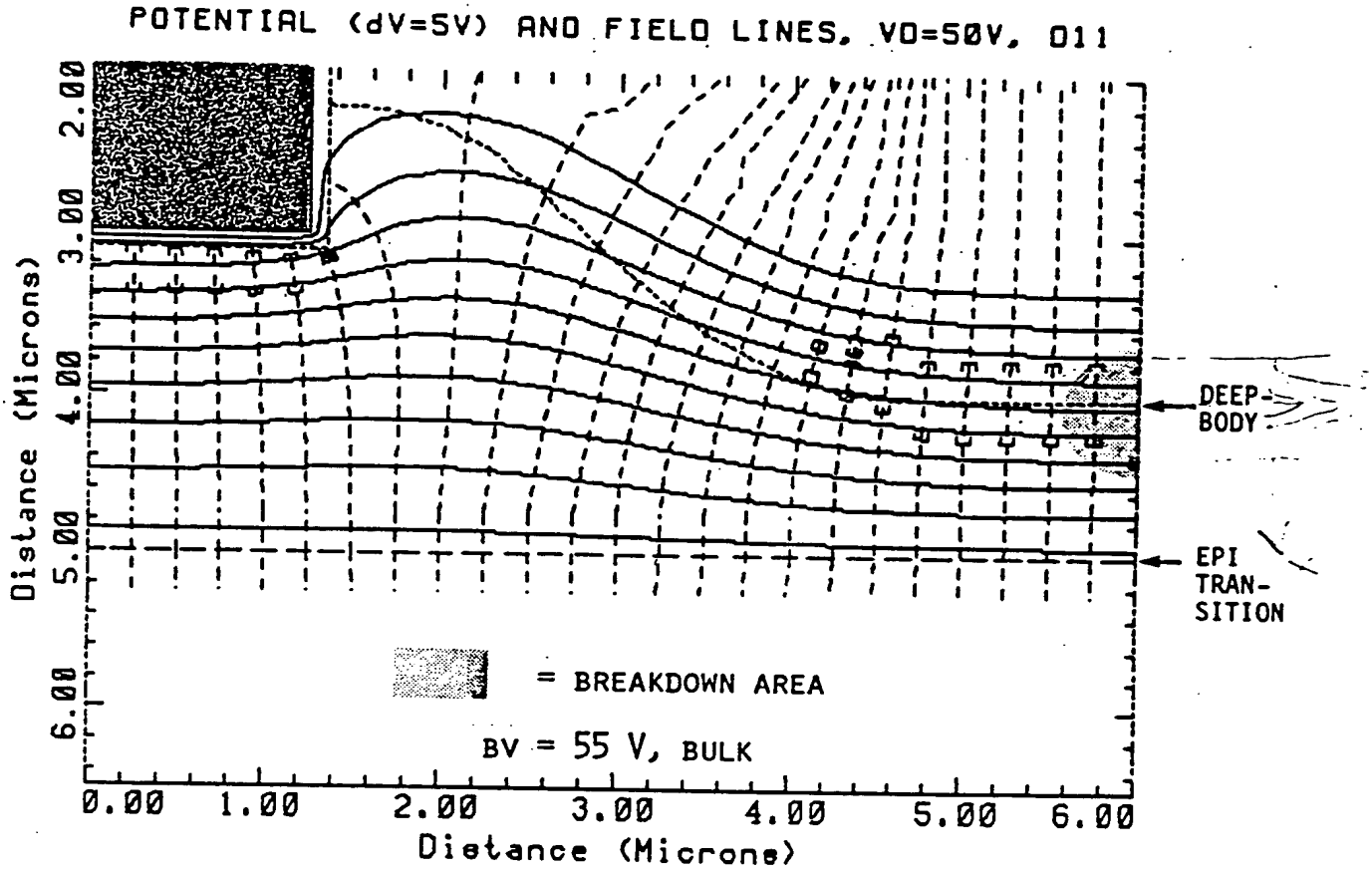


Figure 8

3-D representation of the optimized trenched DMOS transistor cell proposed in this Patent Application.

08/185,608

~~08/086976~~



α_{eff} $d_{ij} = 1$, α_{eff} = strong (exp) funct. of E

$\alpha_{eff} = AEe^{-B/E}$

Figure 9

2-D computer simulation of the BVDSS operation of a trenched DMOS transistor having the deep body junction deeper than the trench. Drain breakdown takes place in the bulk.

read and understood August 10, 1988
read and understood August 4, 1988

"BLACK SILICON" COMPARISON

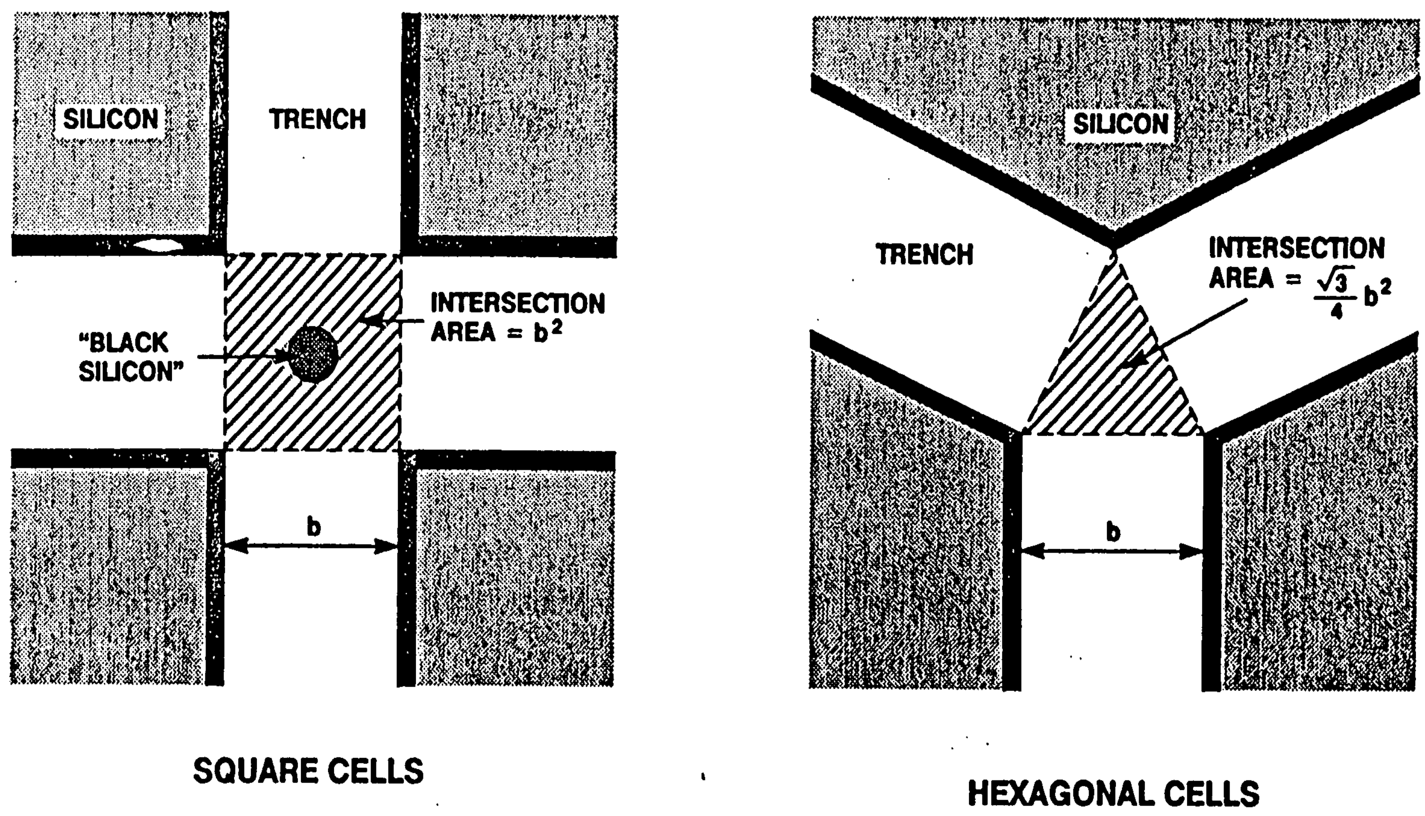


Figure 10

Comparison of the "black silicon" areas at trench intersections: square cell (left) versus hexagonal cell (right).

6/88

~~08/086976~~ 08/851608

read & understood [illegible] August 10, 1988
read and understood Randolph [illegible] August 11, 1988

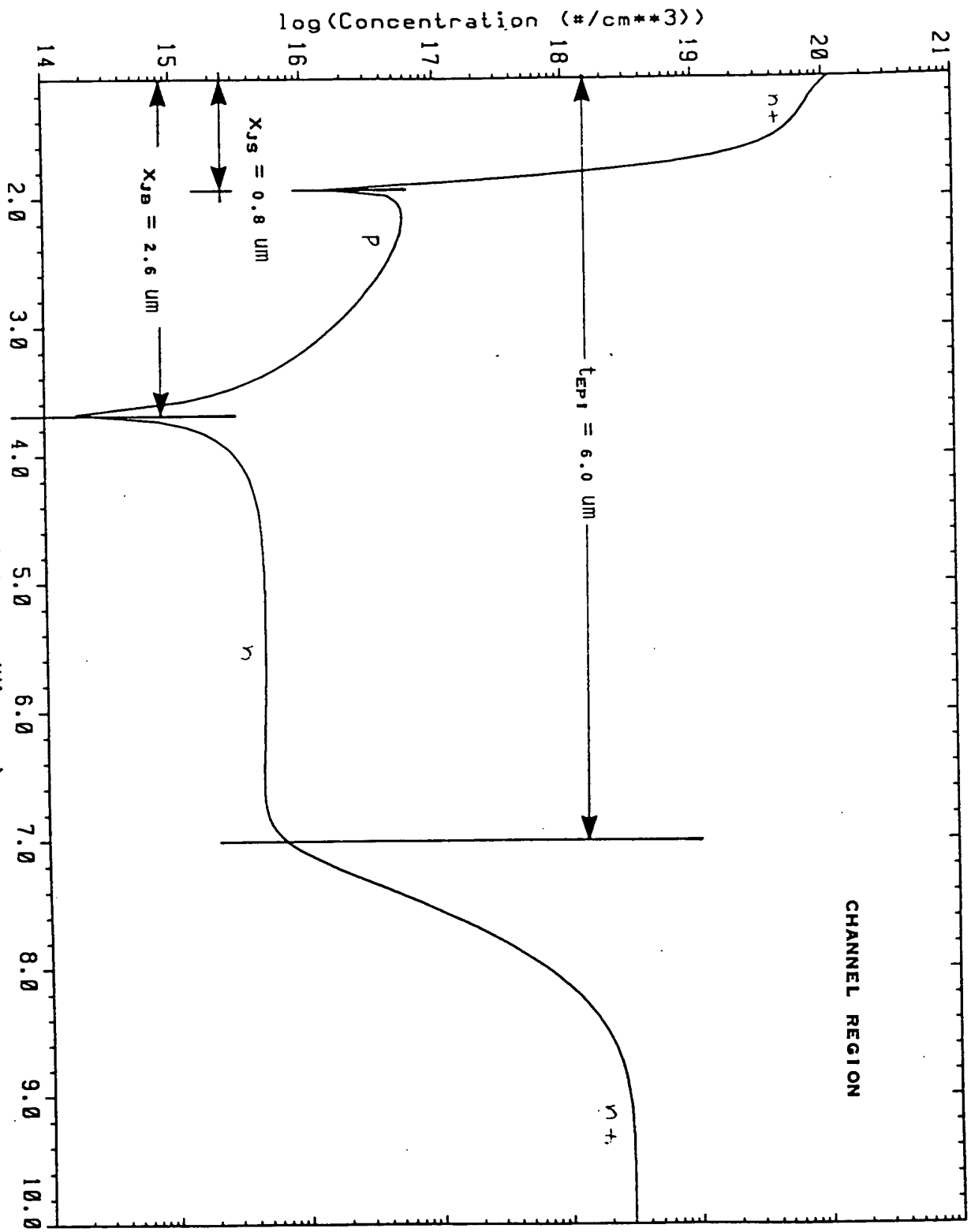


Fig 11

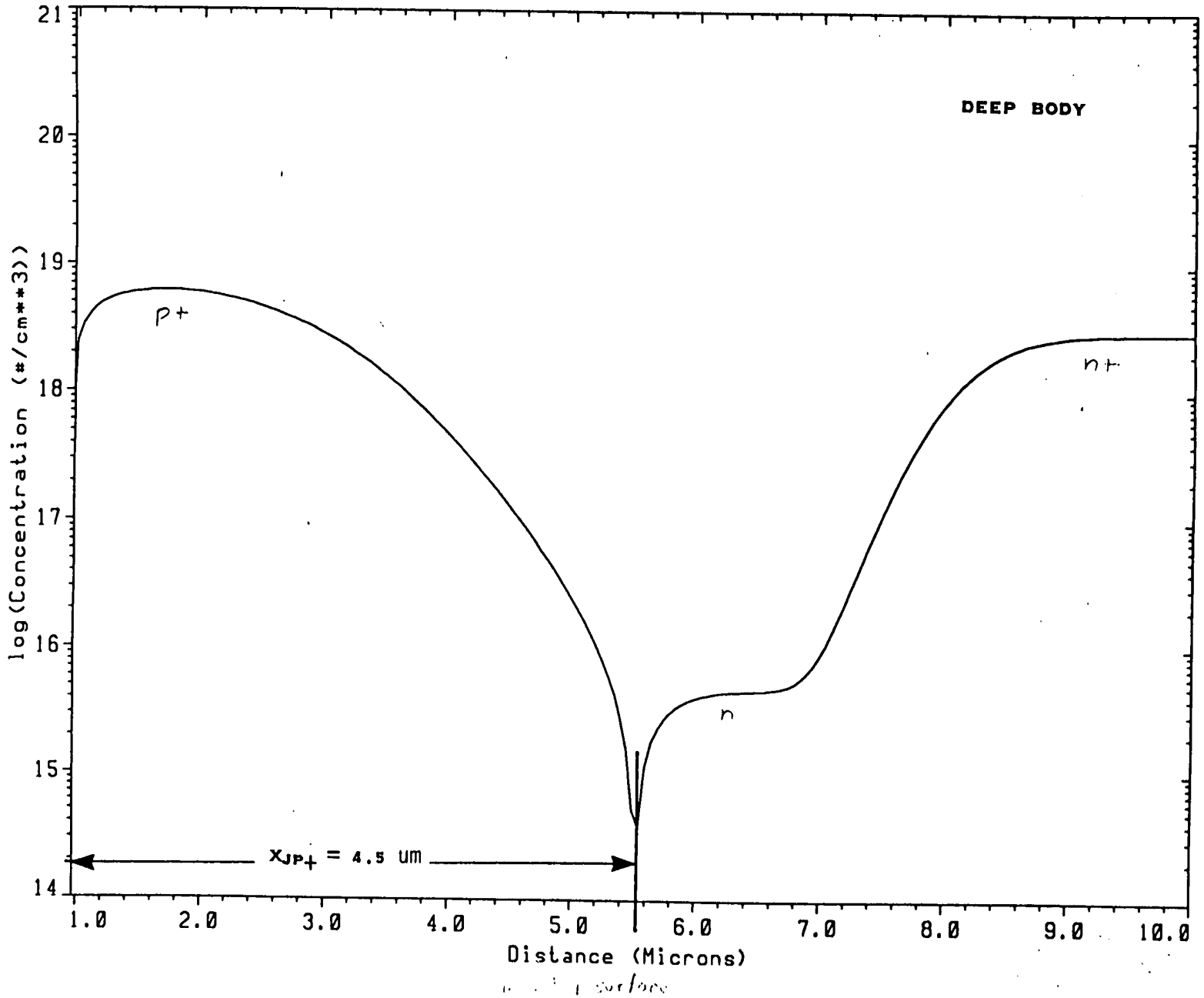


Fig. 12

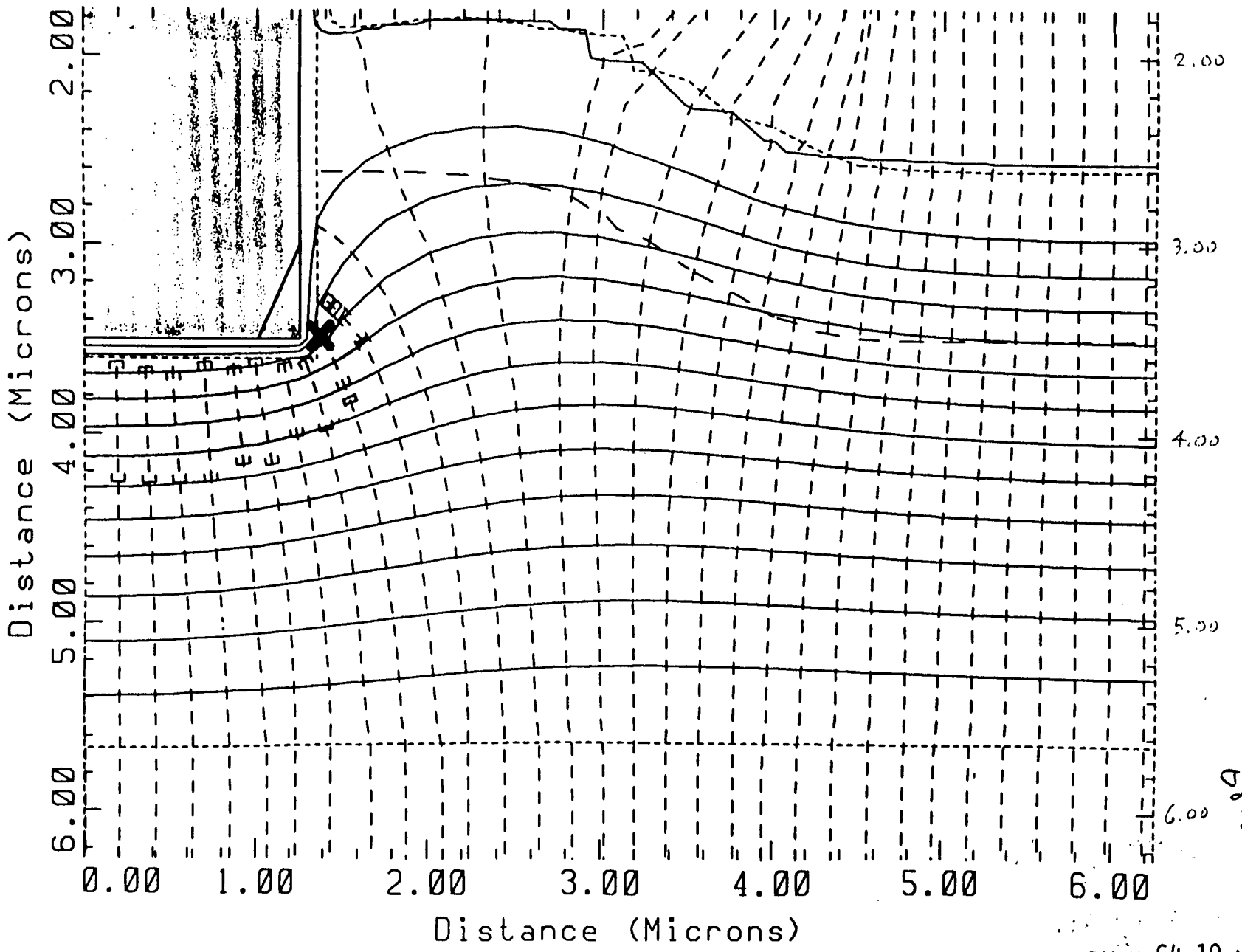

ELECTRIC FIELD, VD=50V, dV=4.0V, E.MARK=2.5E5V/cm - G32J
Distance (Microns)
2.00
3.00
4.00
5.00
6.00
0.00
1.00
2.00
3.00
4.00
5.00
6.00
Distance (Microns)
BV = 64.19 V
SURFACE

Fig 13

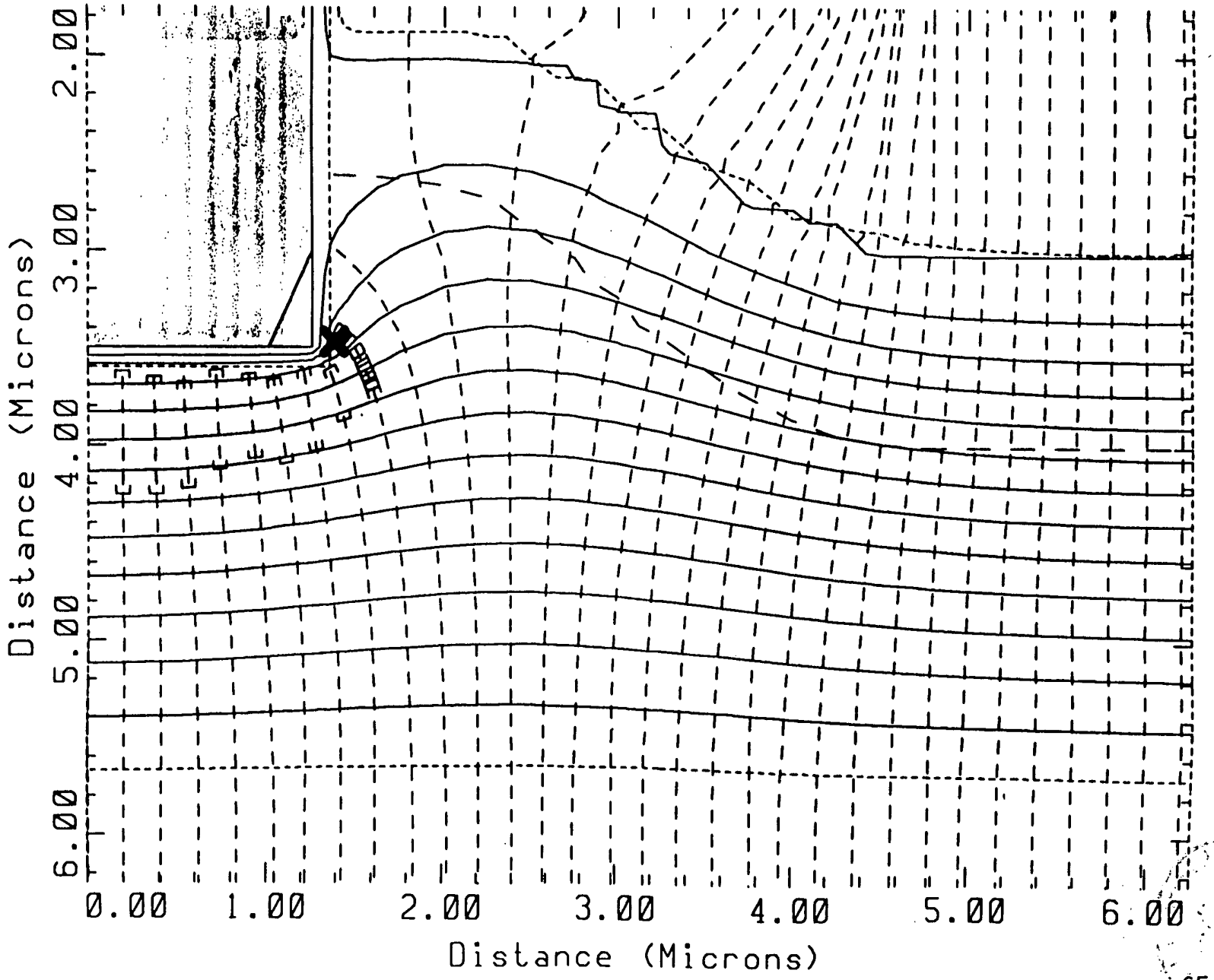

ELECTRIC FIELD, VD=50V, dV=4.0V, E.MARK=2.5E5V/cm - G32k
Distance (Microns)
2.00
3.00
4.00
5.00
6.00
0.00
1.00
2.00
3.00
4.00
5.00
6.00
Distance (Microns)
BV = 65.20 V
SURFACE

Fig. 14

08/086976

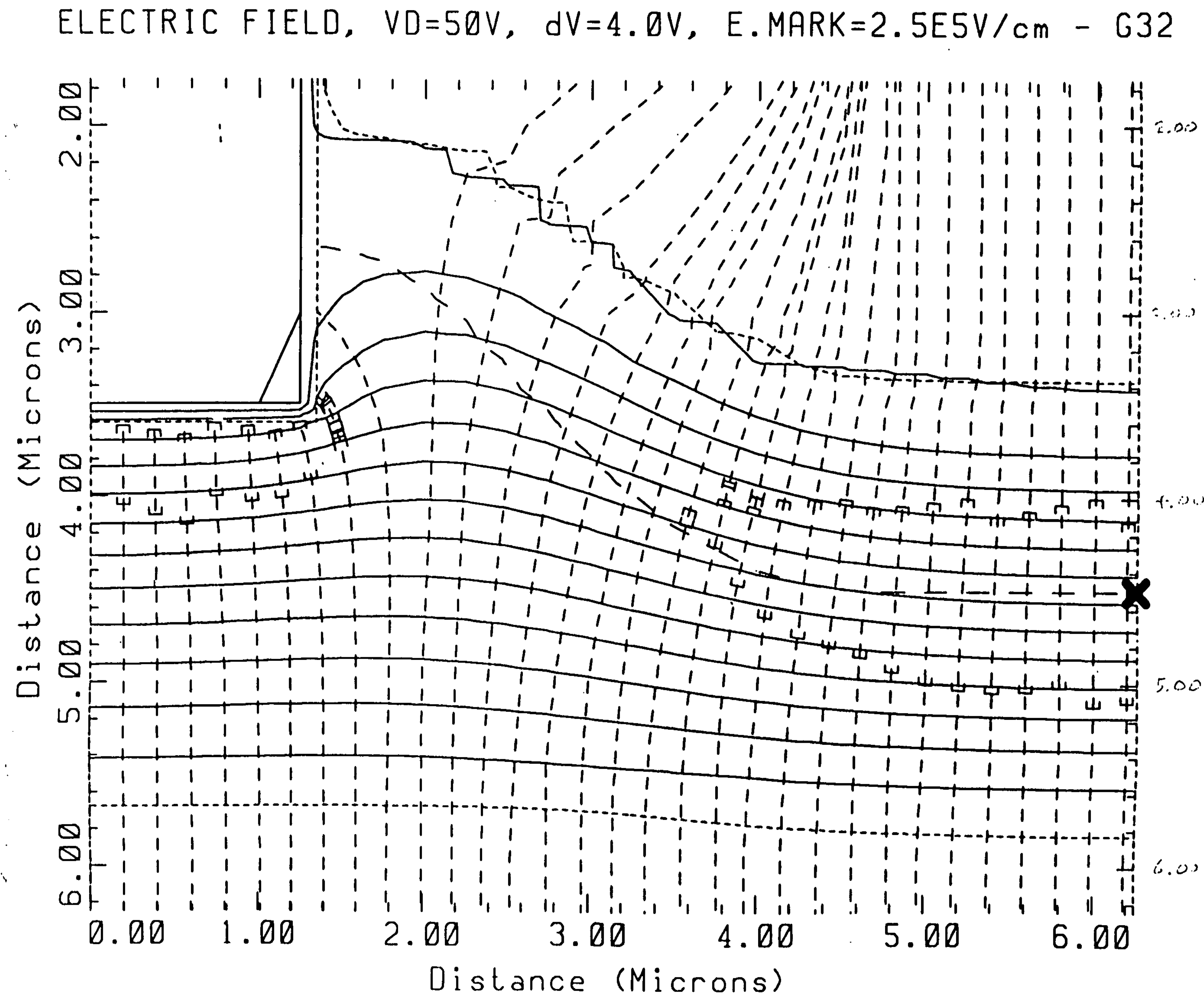


Fig. 15

BV = 61.81 V
BULK

08/857608

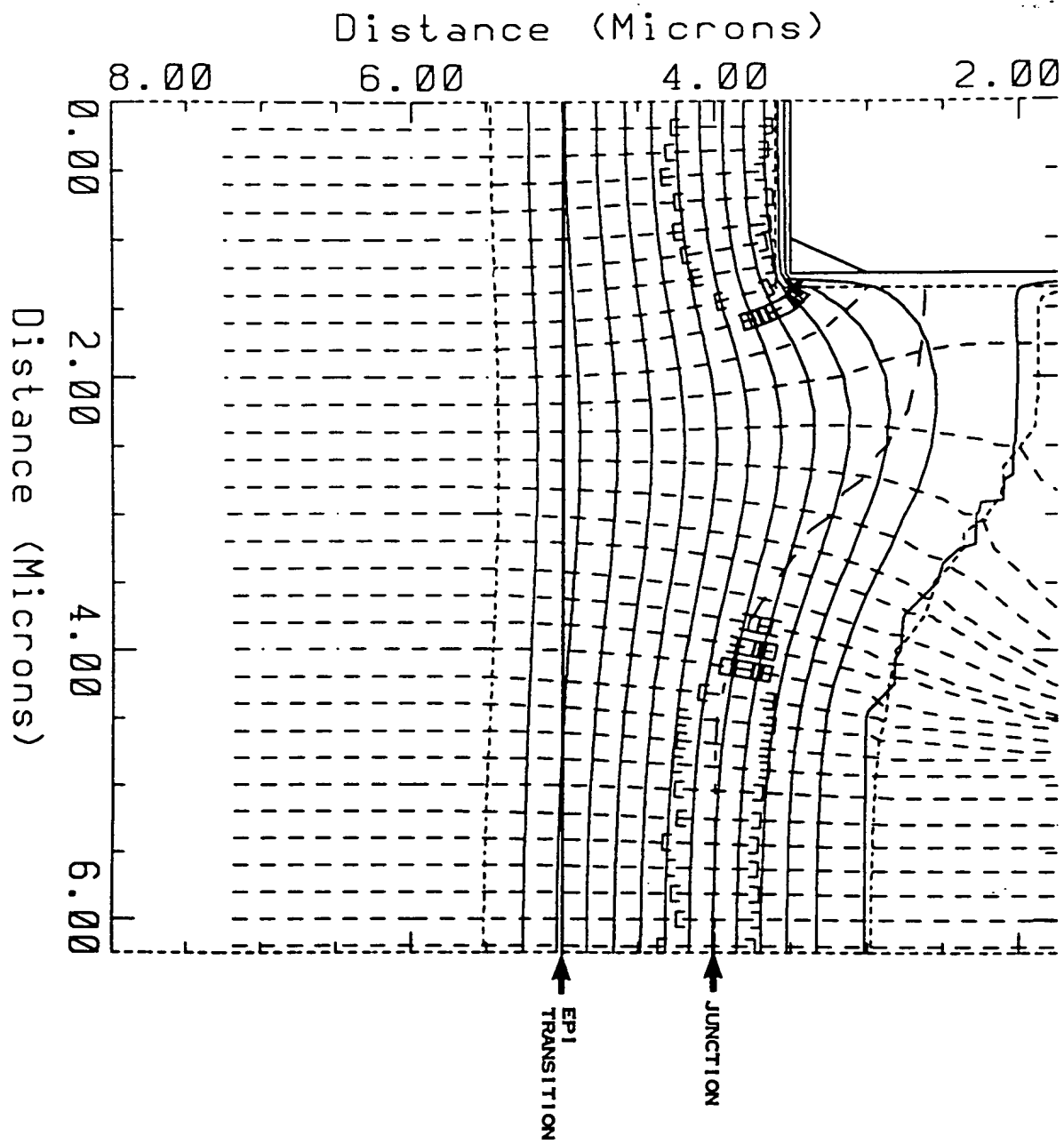


FIG 18

BV = 61.25 v
SURFACE

809/581/80

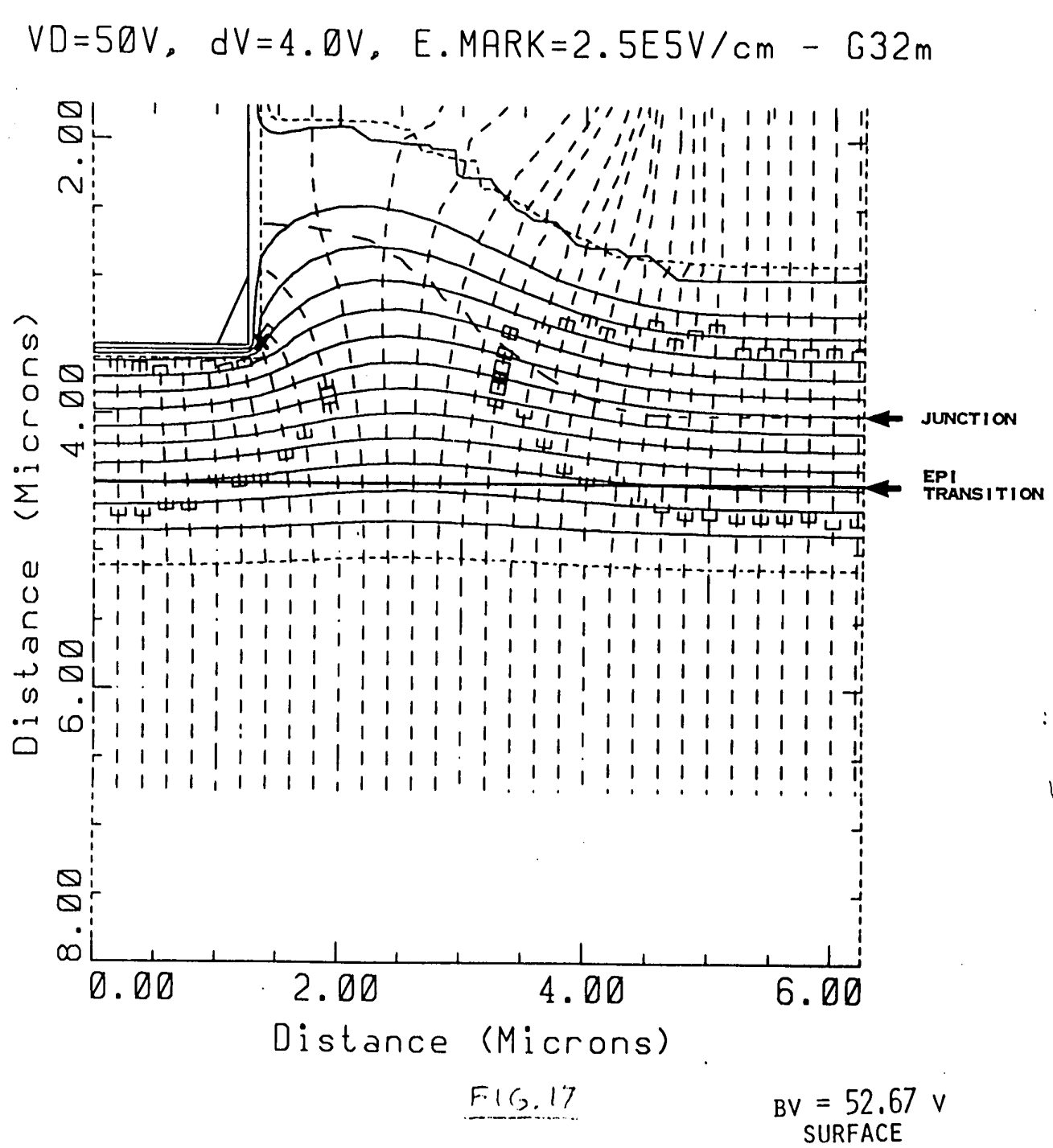

VD=50V, dV=4.0V, E.MARK=2.5E5V/cm - G32m
Distance (Microns)
2.00
4.00
6.00
8.00
0.00
2.00
4.00
6.00
Distance (Microns)
JUNCTION
EPI
TRANSITION
BV = 52.67 V
SURFACE

FIG. 17

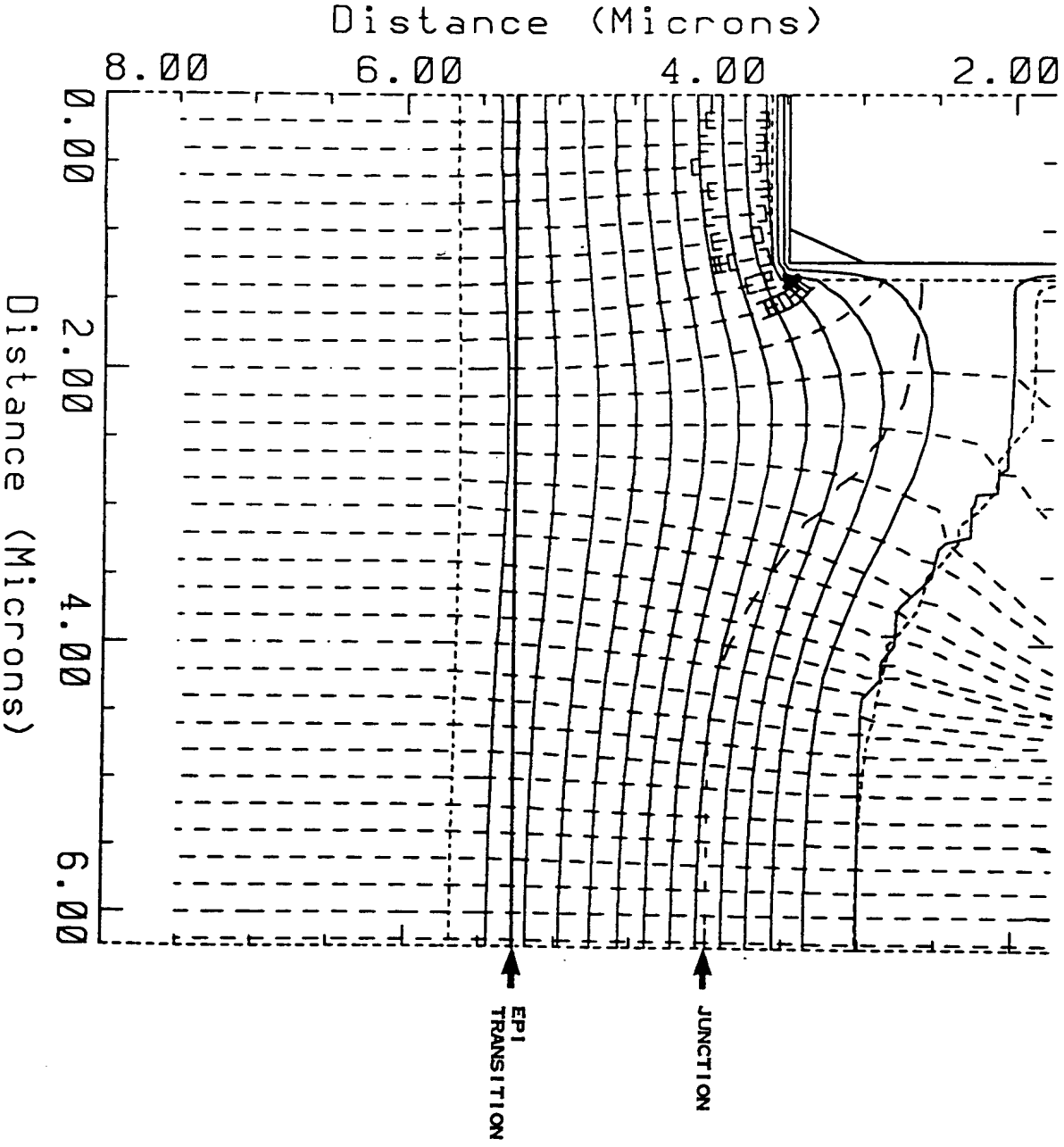


FIG. 18

809/58/80

08/185,608

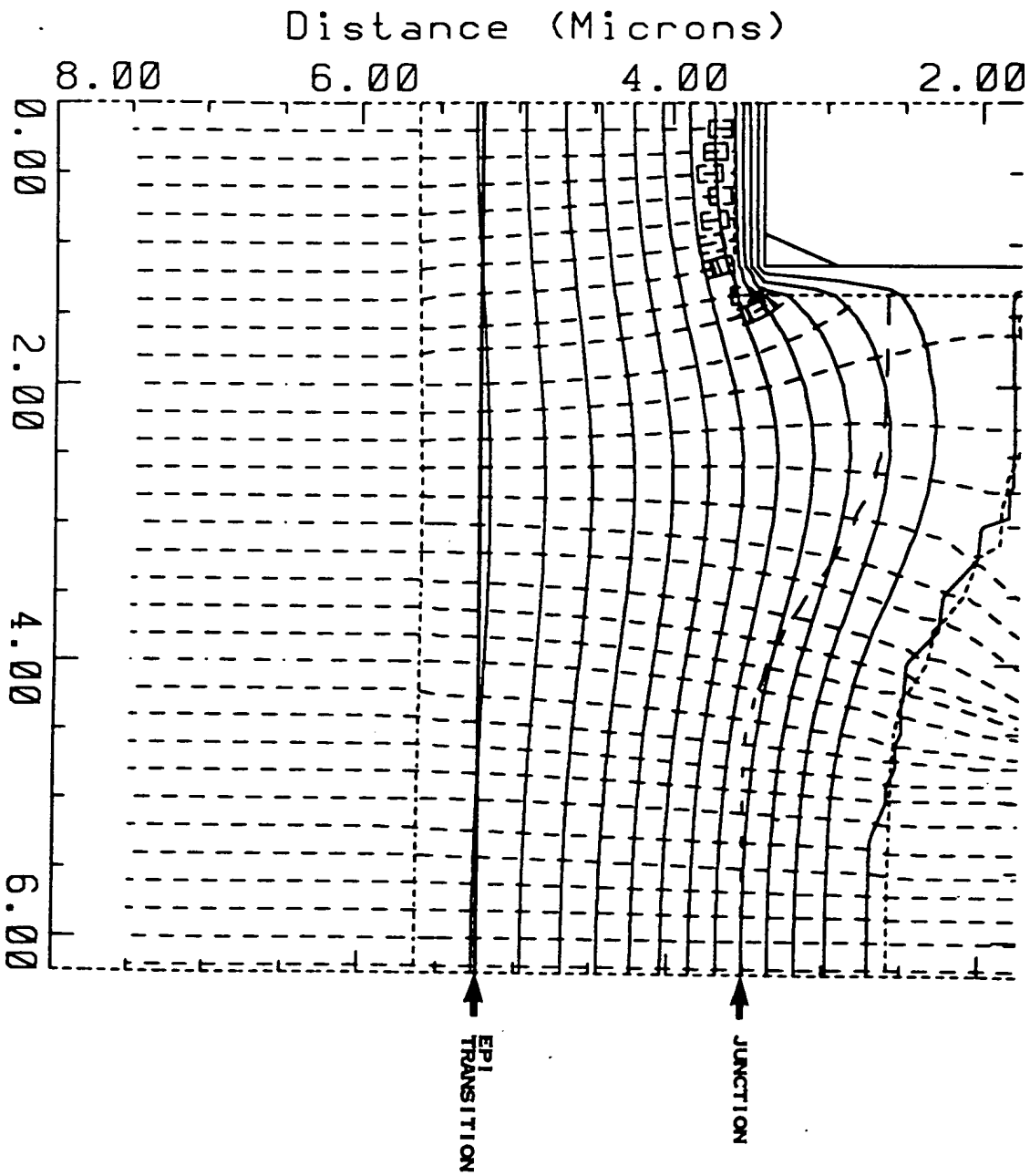


FIG. 19

BV = 74.93 V
SURFACE

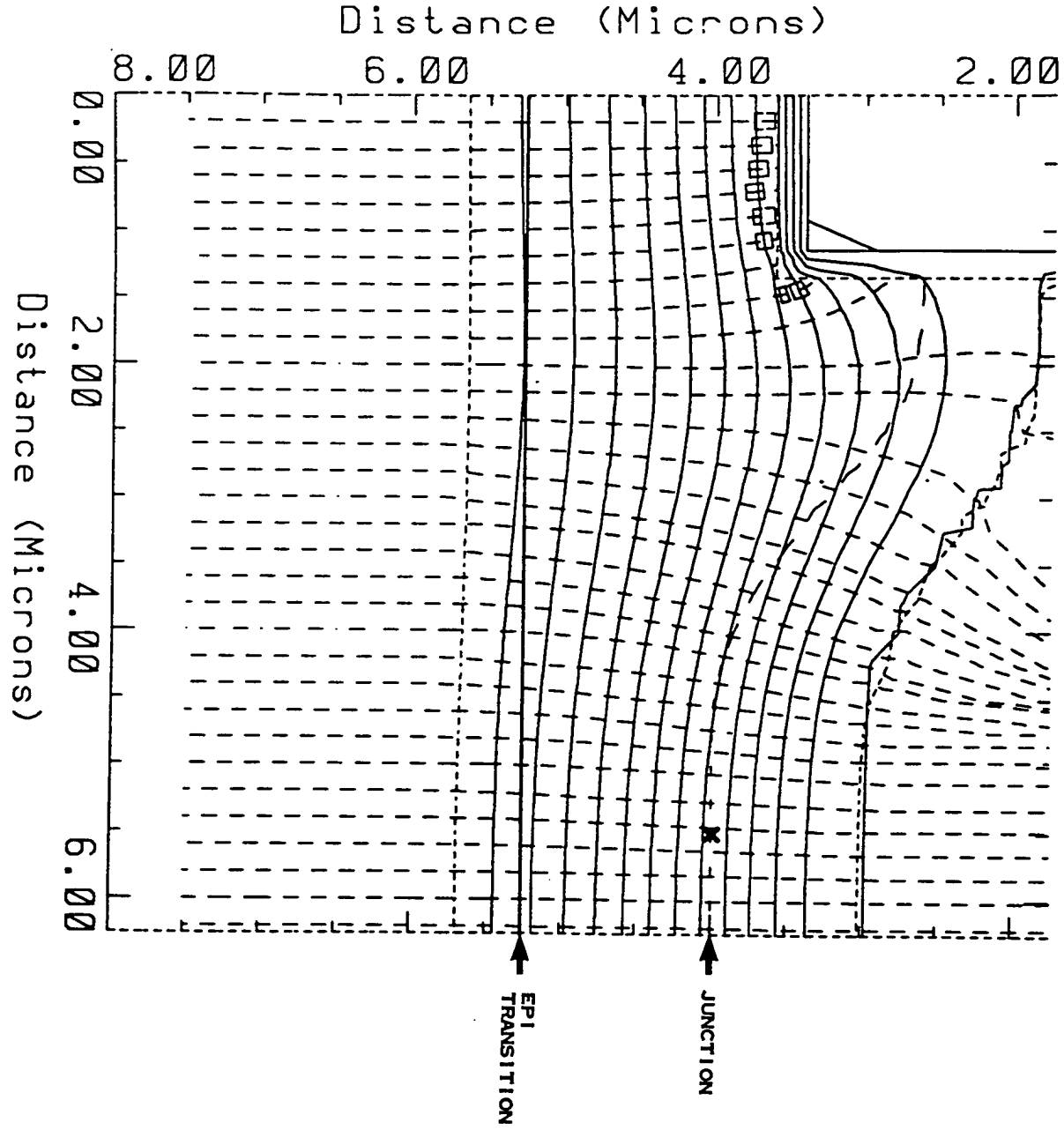

Distance (Microns)
8.00
6.00
4.00
2.00
0.00
2.00
4.00
6.00
Distance (Microns)
VD=50V, dV=4.0V, E.MARK=2.5E5V/cm - G32w
EPI TRANSITION
JUNCTION
BV = 69.53 V
BULK

FIG. 20

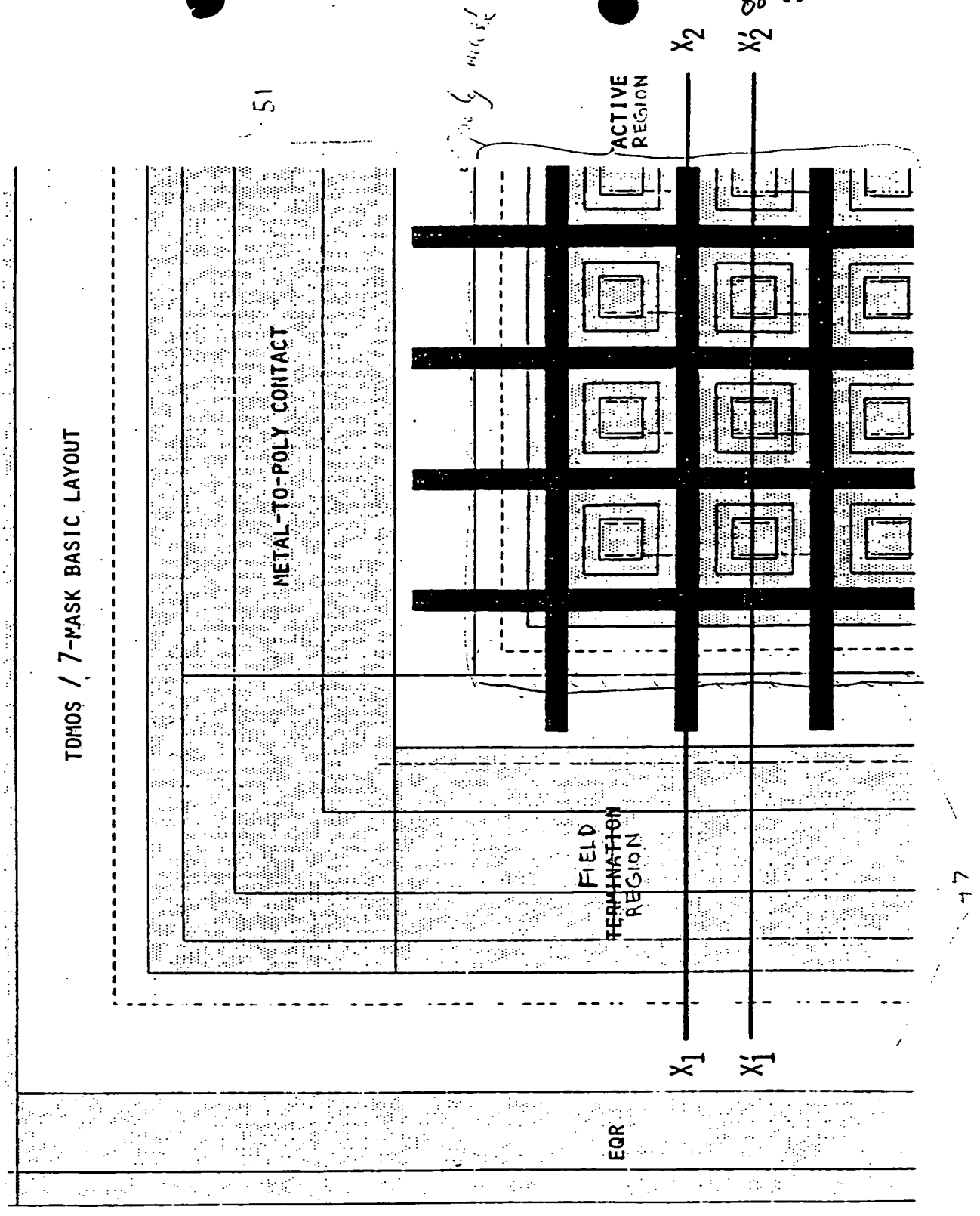


Fig. 21

read and understood RK Wh August 10, 1988
read and understood Randolph Dill August 11, 1988

0.6 μm

7-MASK TDMOS – PROCESSING BLOCK 1

n/n+ EPI → POST-EPI OXIDATION → MASK 1 = DEEP BODY → BORON IMPLANT & DIFFUSION / OXIDATION →

MASK 1 = DEEP BODY

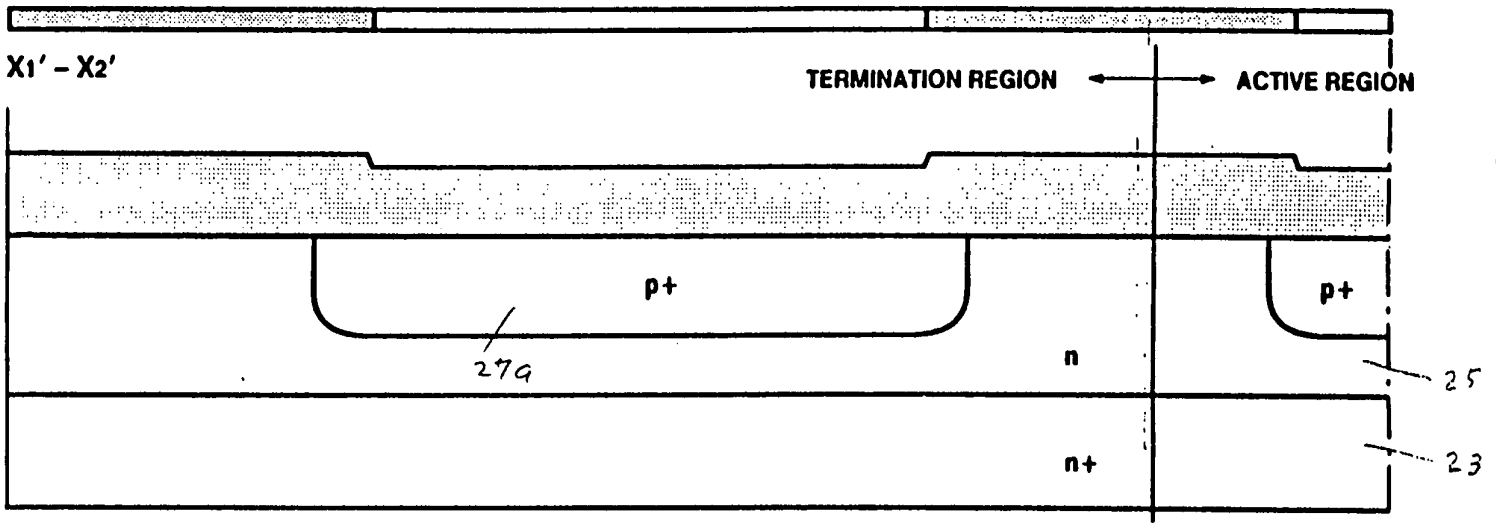


Fig. 2A

MASK 1 = DEEP BODY

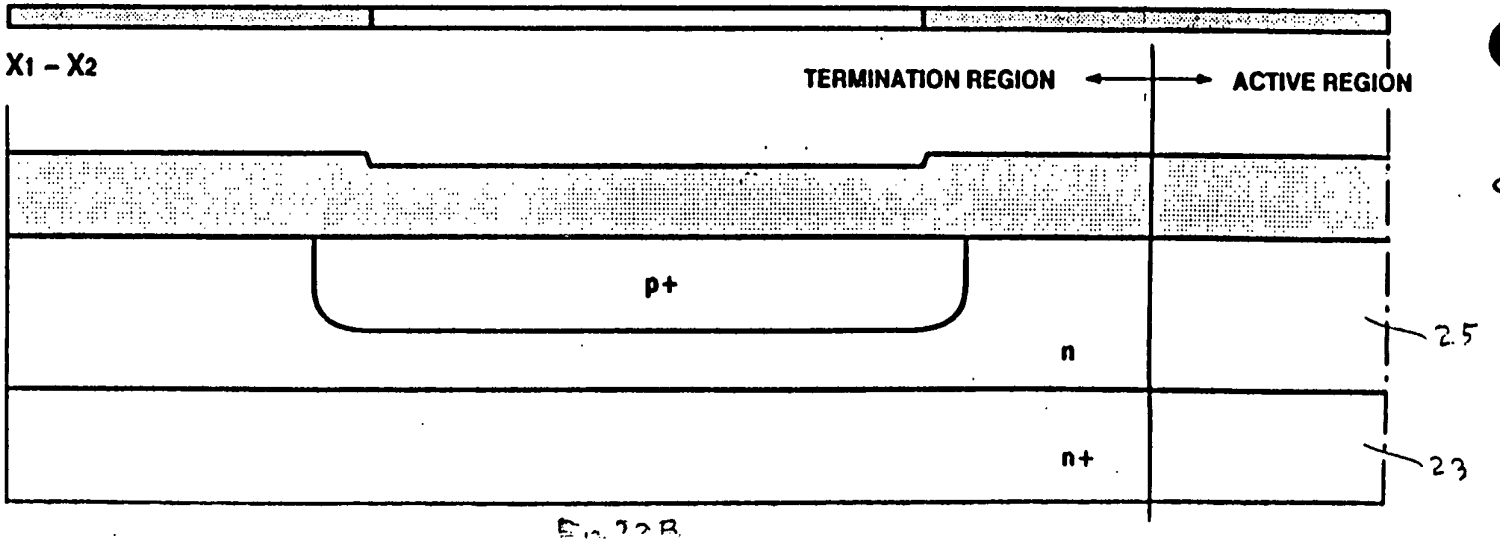


Fig. 2B

read and understood by Applicant, August 10, 1988
read and understood by Robert Dahl August 4, 1988

08/185,608

7-MASK TDMOS – PROCESSING BLOCK 2

➡ MASK 2 = ACTIVE ➡ BORON IMPLANT & DIFFUSION / OXIDATION ➡ ARSENIC IMPLANT & DIFFUSION / OXIDATION ➡ LTO DEPOSITION

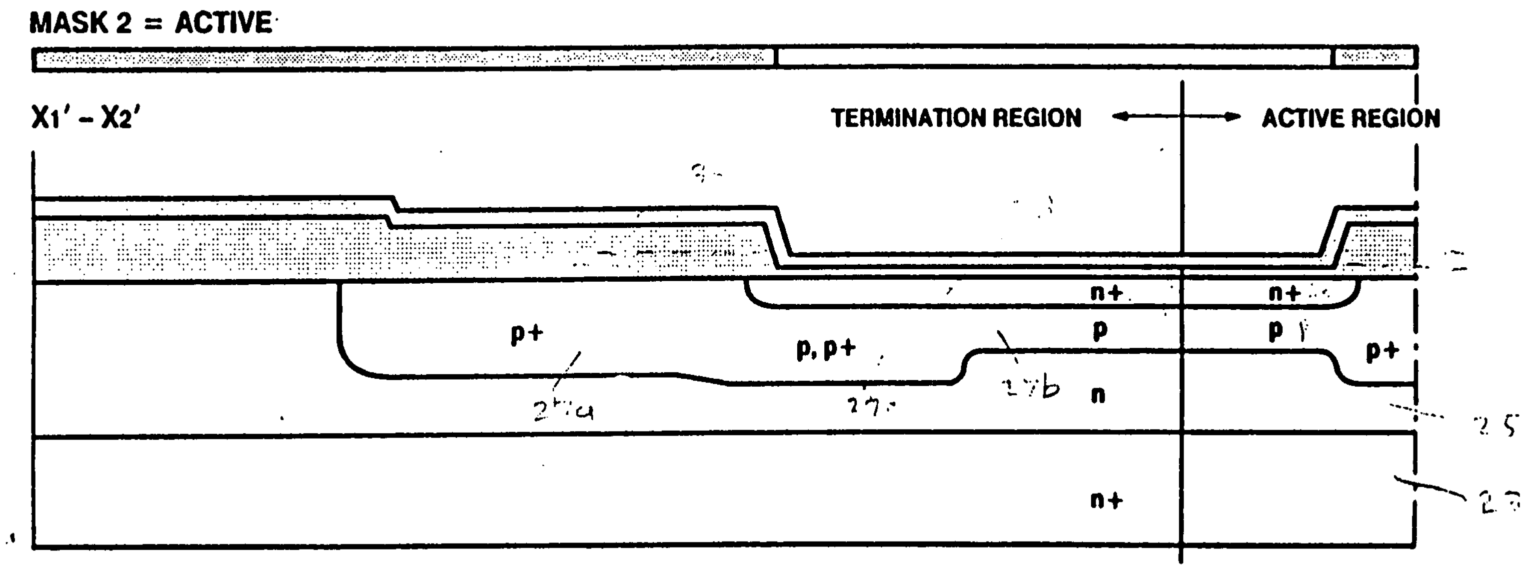


Fig. 23A

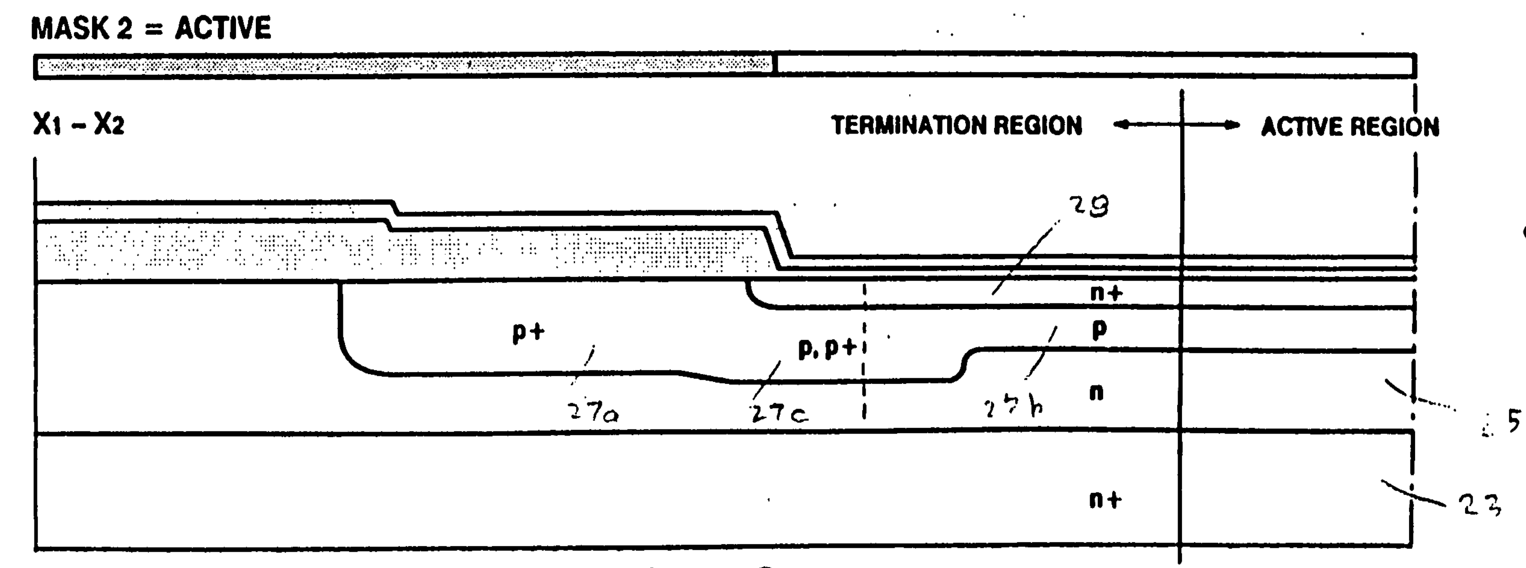


Fig. 23B

read & understood [signature] August 10, 1988
read and understood [signature] August 11, 1988

08/089976

08/851608

7-MASK TDMOS—PROCESSING BLOCK 3

→ MASK 6 = TRENCH → TRENCH DRY ETCHING →

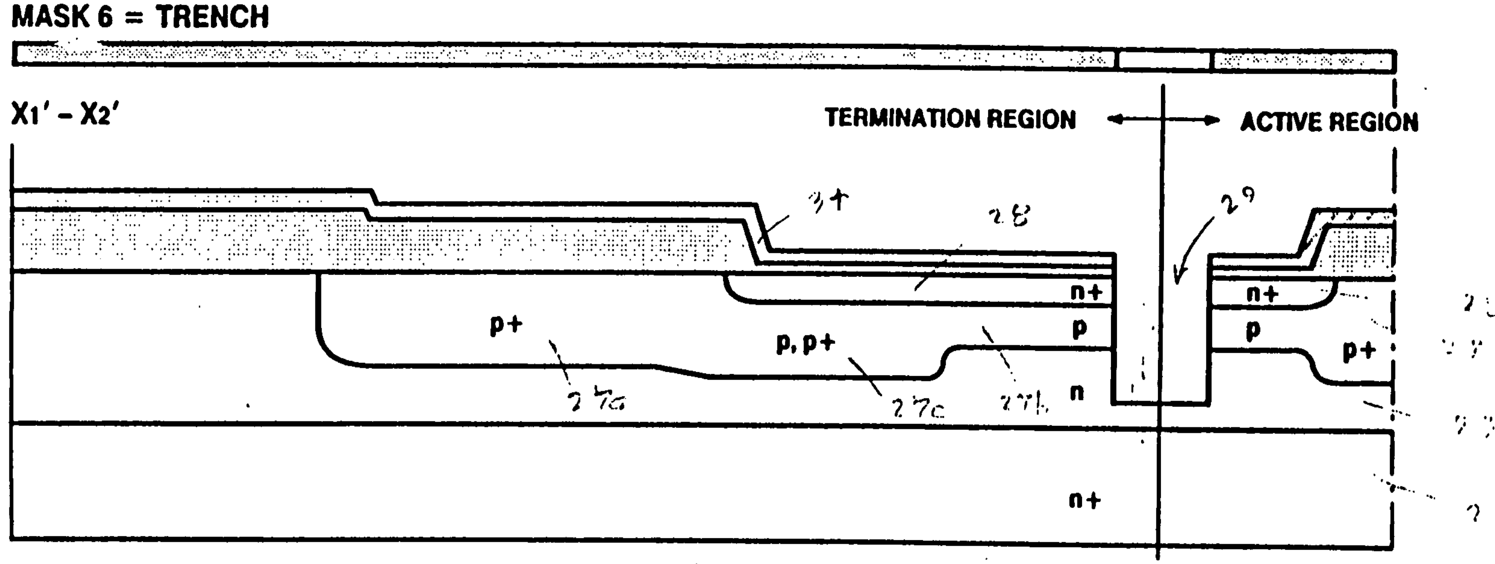
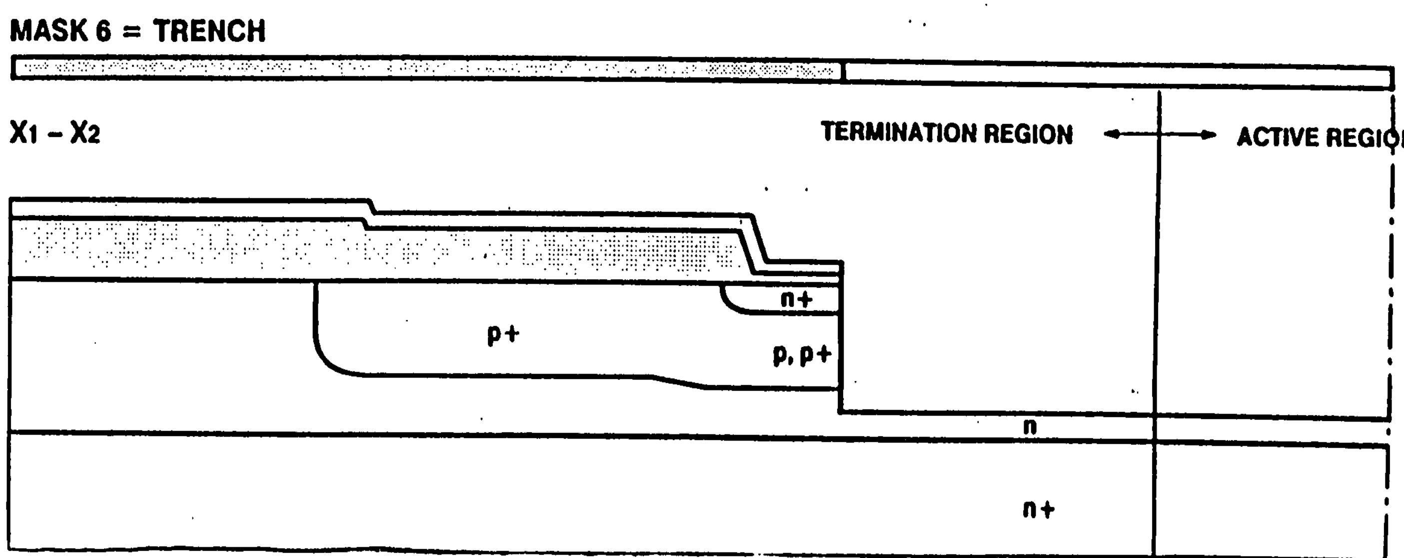


Fig. 24A



08/851608

read + understood [signature] August 10, 1988
read and understood Randolph D. [signature] August 11, 1988

08/086976

read & understood RKW August 10, 1988
read and understood Rockwell August 11, 1988

7-MASK TDMOS – PROCESSING BLOCK 4

→ SACRIFICIAL OXIDATION & ETCHING → GATE OXIDATION →

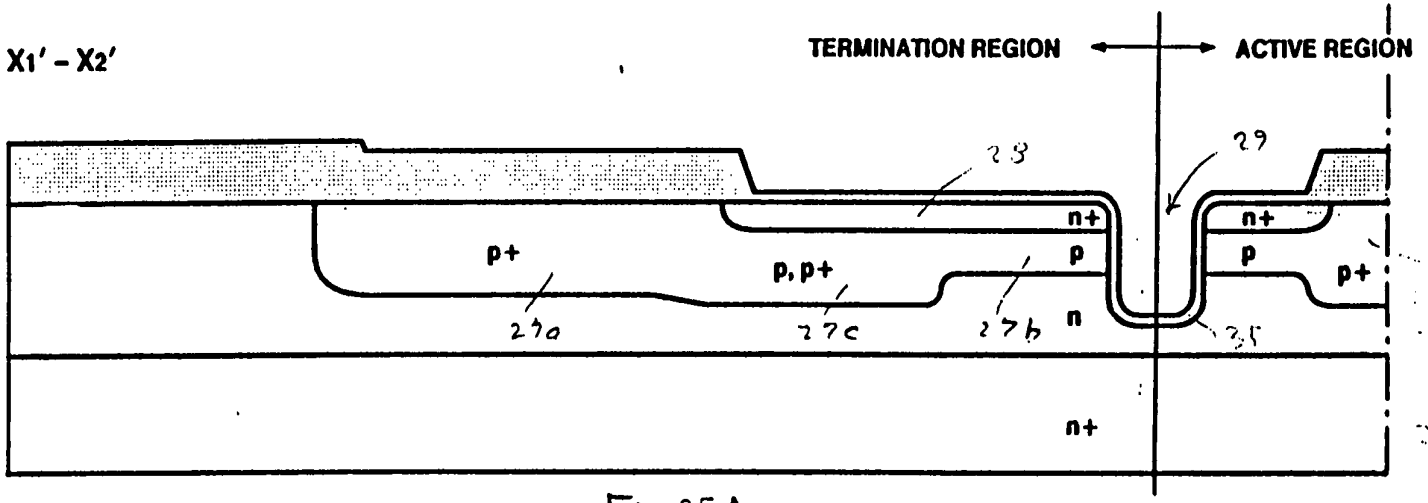


Fig. 25A

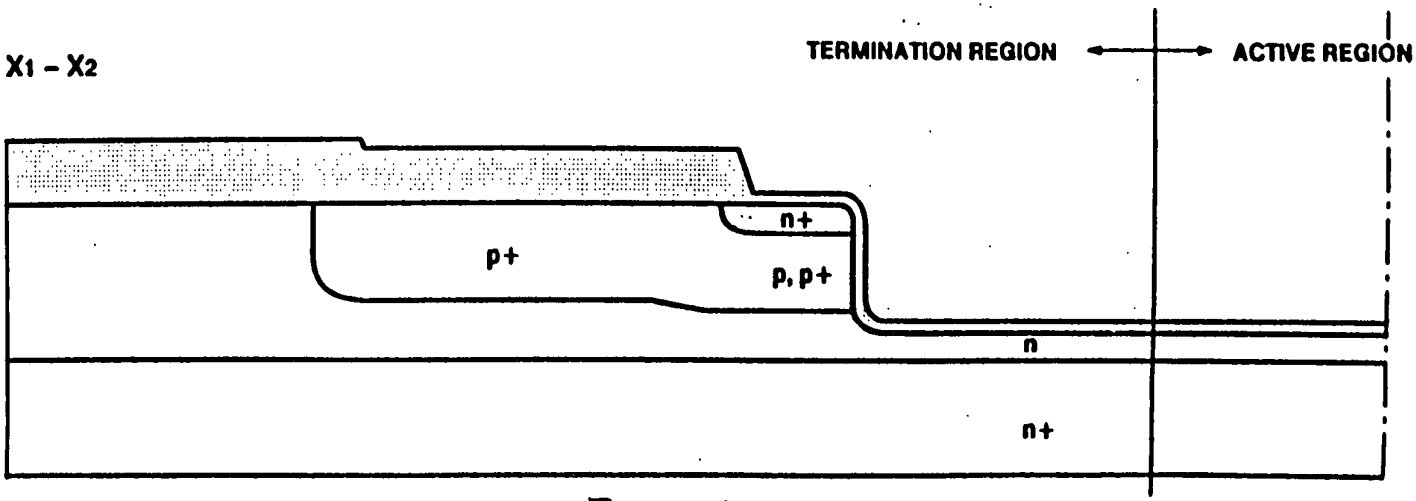


Fig. 25B

read & understood BKW August 10, 1988
read and understood Randolph D. Keil August 4, 1988

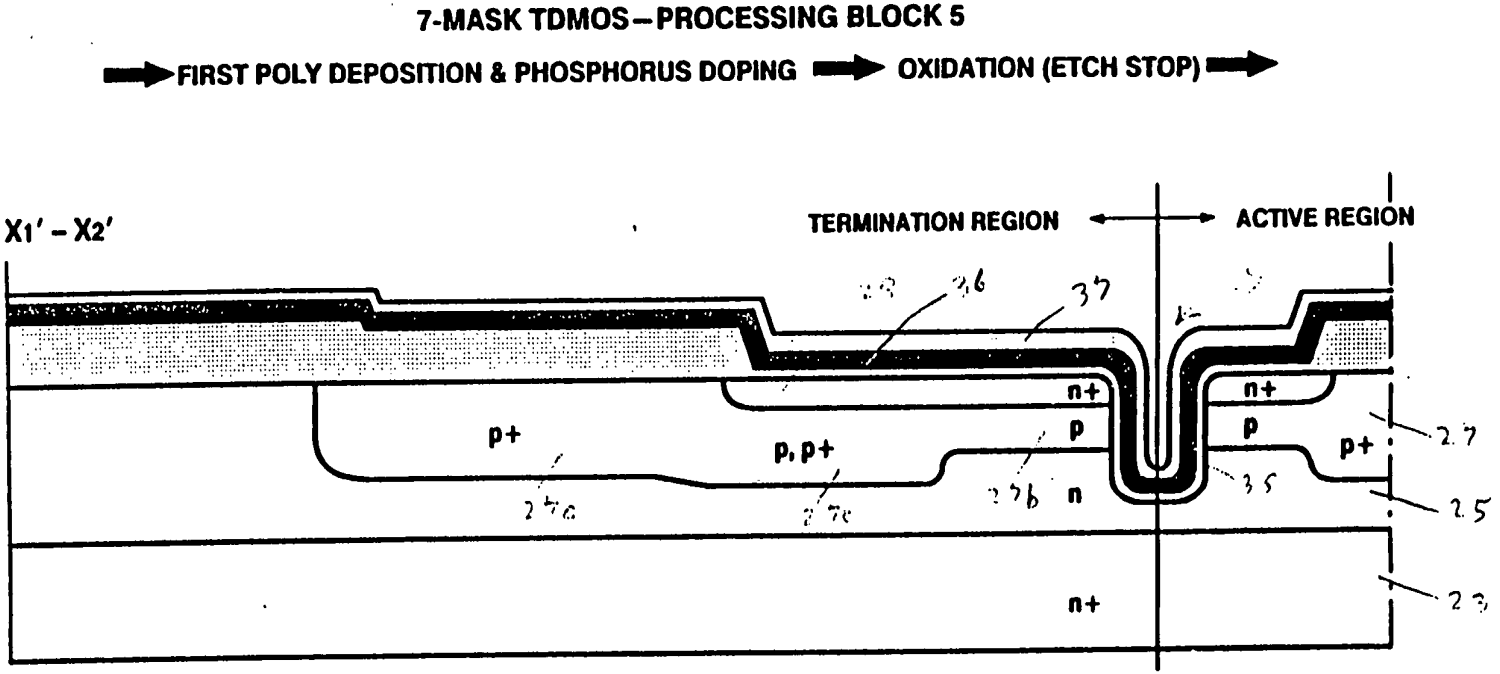


Fig. 26A

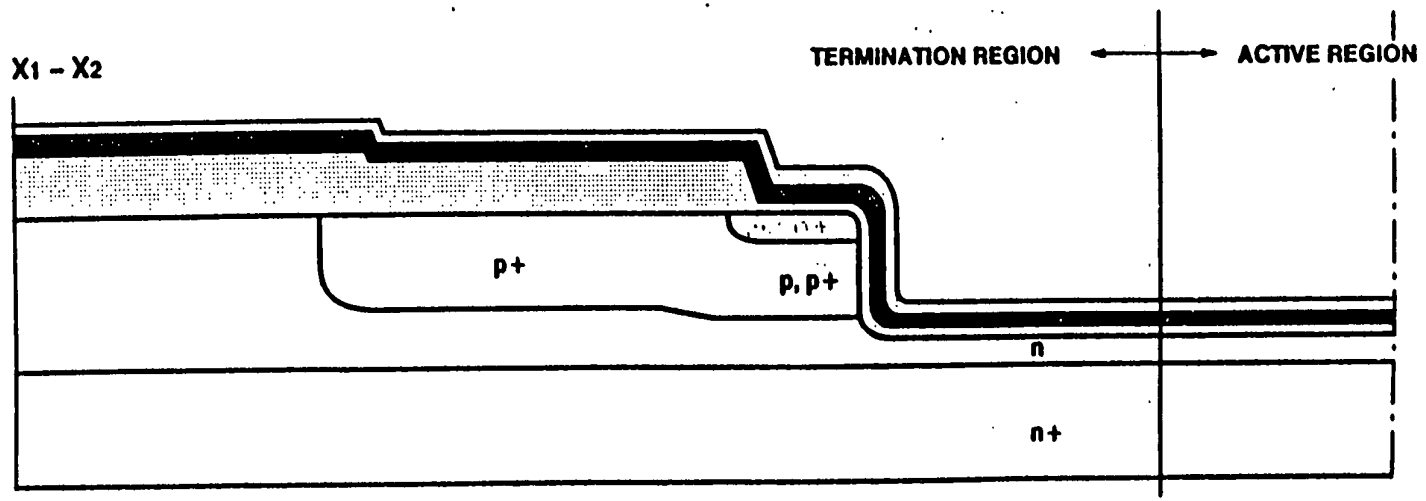


Fig. 26B

7-MASK TDMOS—PROCESSING BLOCK 6

→ SECOND (UNDOPED) POLY DEPOSITION →

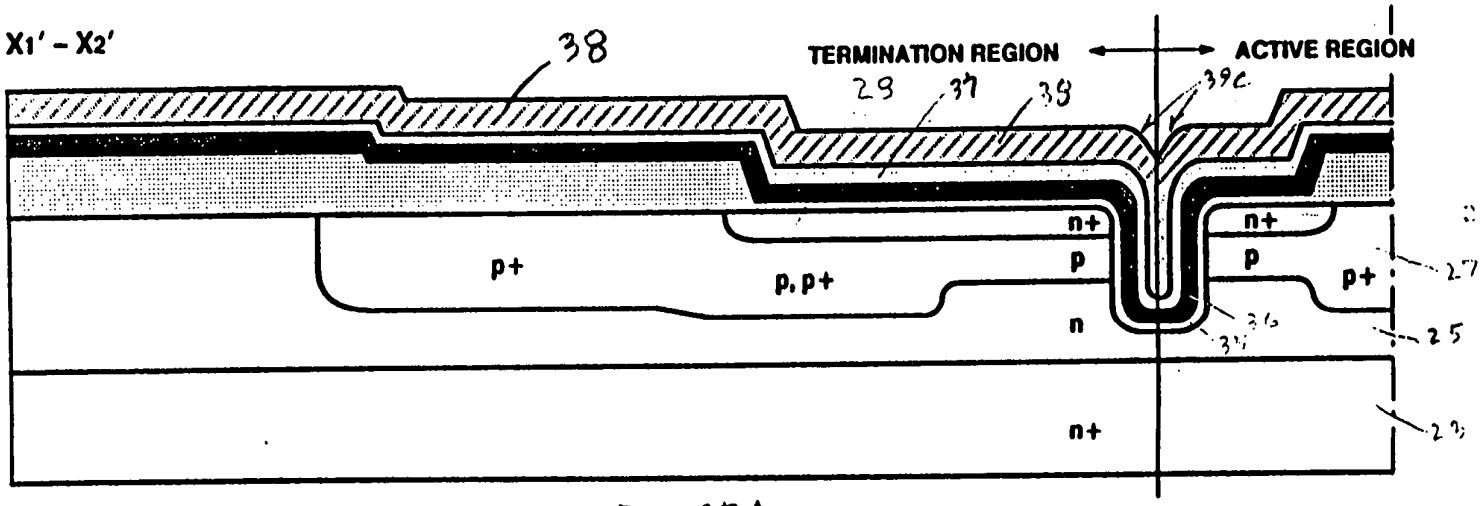


Fig. 27A

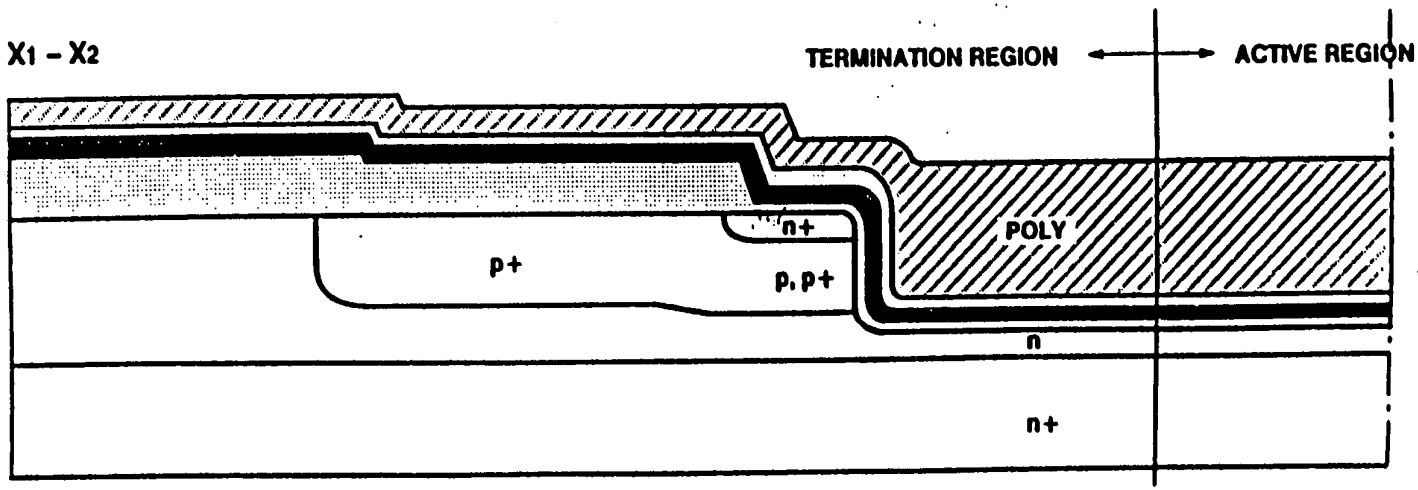


Fig. 27B

08/086976

08/851608

7-MASK TDMOS—PROCESSING BLOCK 7

POLY PLANARIZATION ETCHING → ETCH-STOP-OXIDE STRIP →

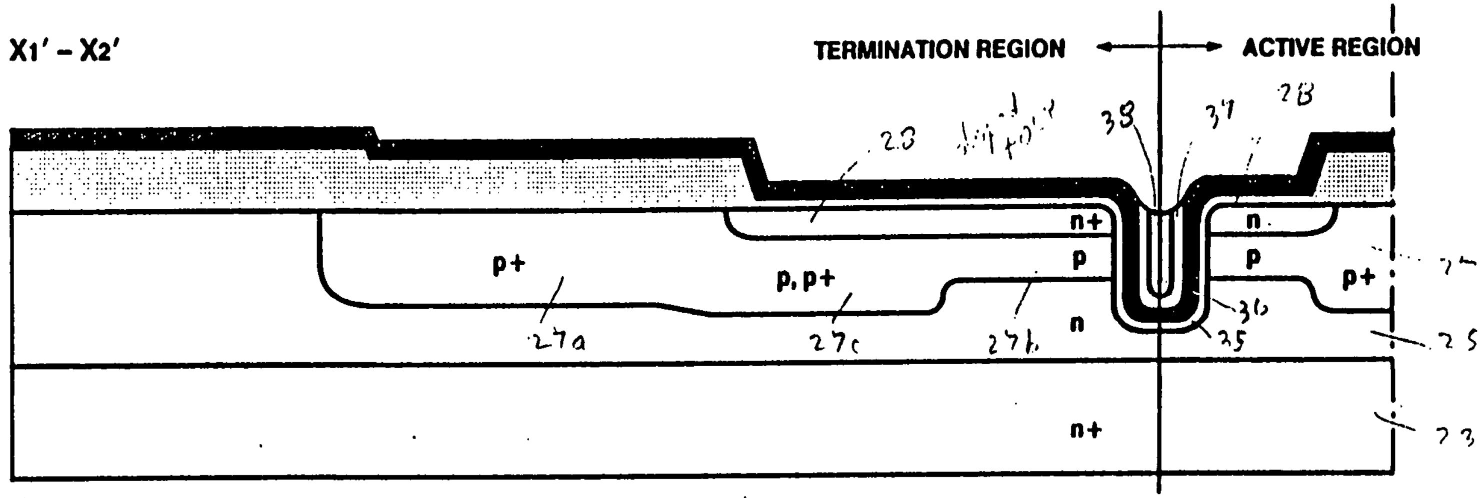


Fig. 28A

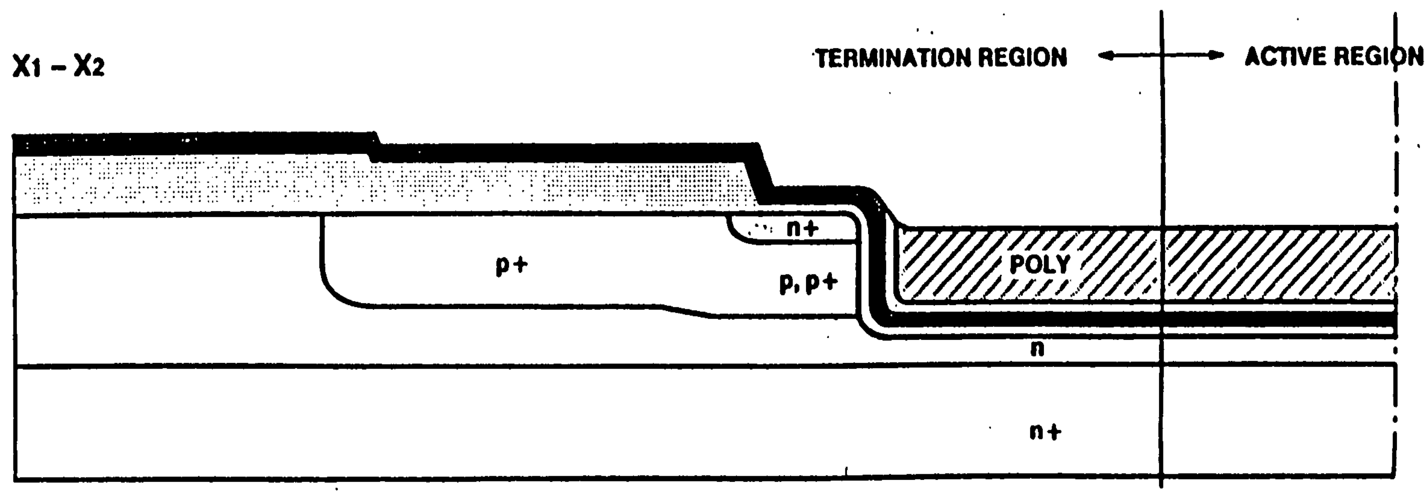


Fig. 28B

read & understood [illegible] August 10, 1988
read and understood [illegible] August 11, 1988

08/851608

7-MASK TDMOS—PROCESSING BLOCK 8

MASK 7 = POLY

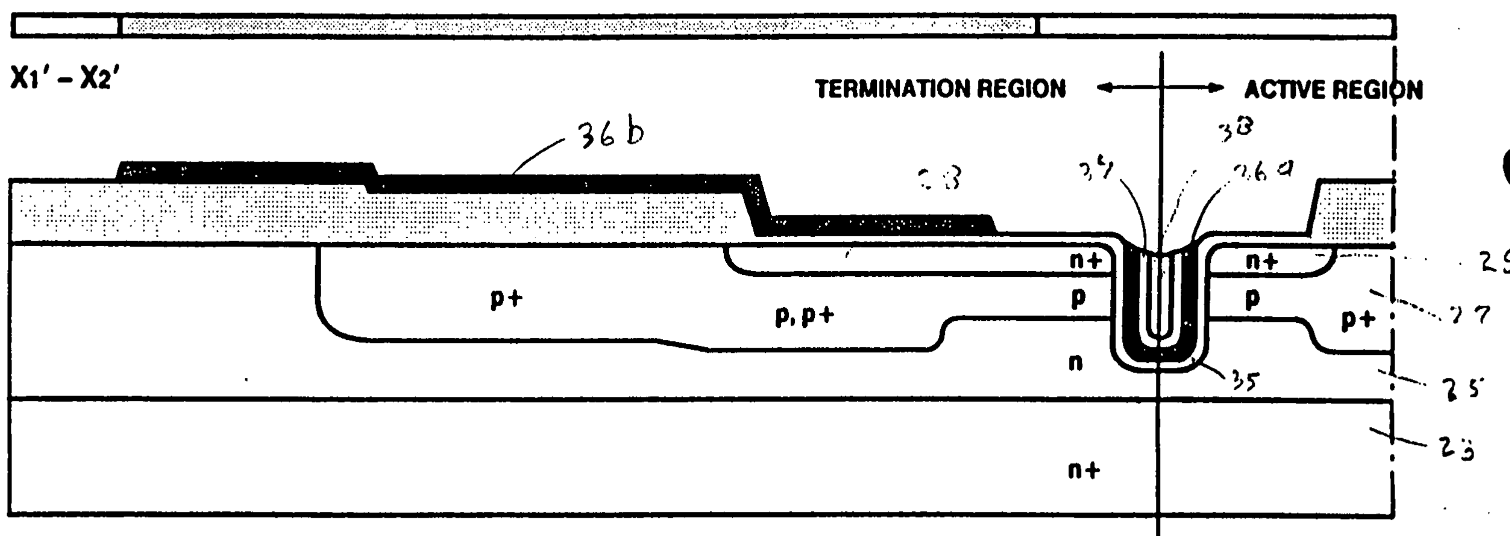


Fig. 29A

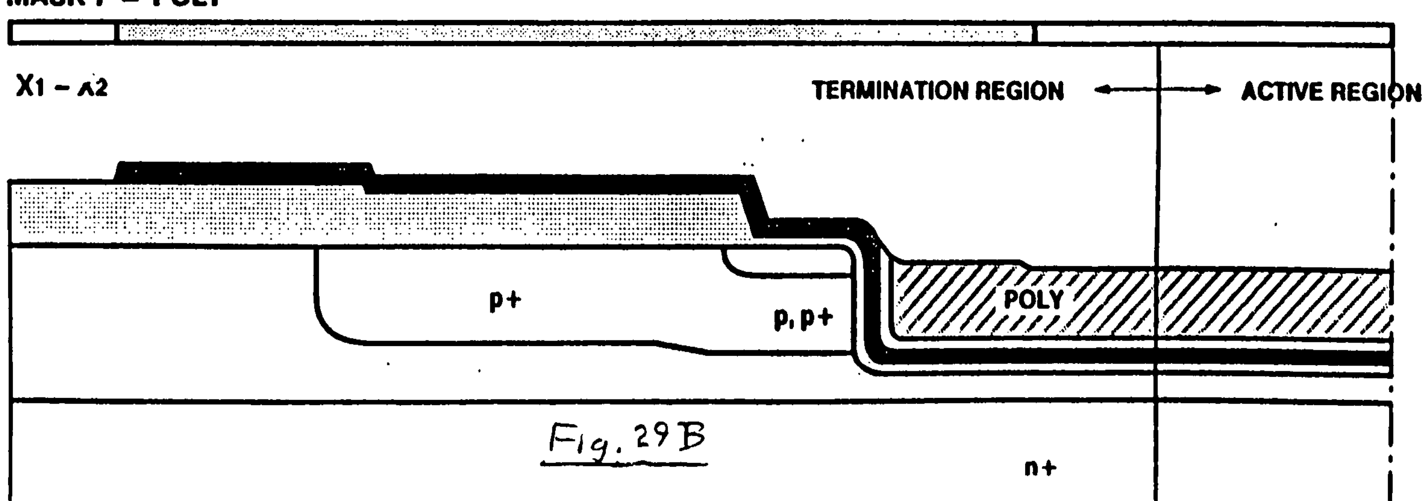


Fig. 29B

read & understood [signature] August 10, 1988
read and understood Randolph D. [signature] August 11, 1988

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08/851,608

~~07~~ 086976

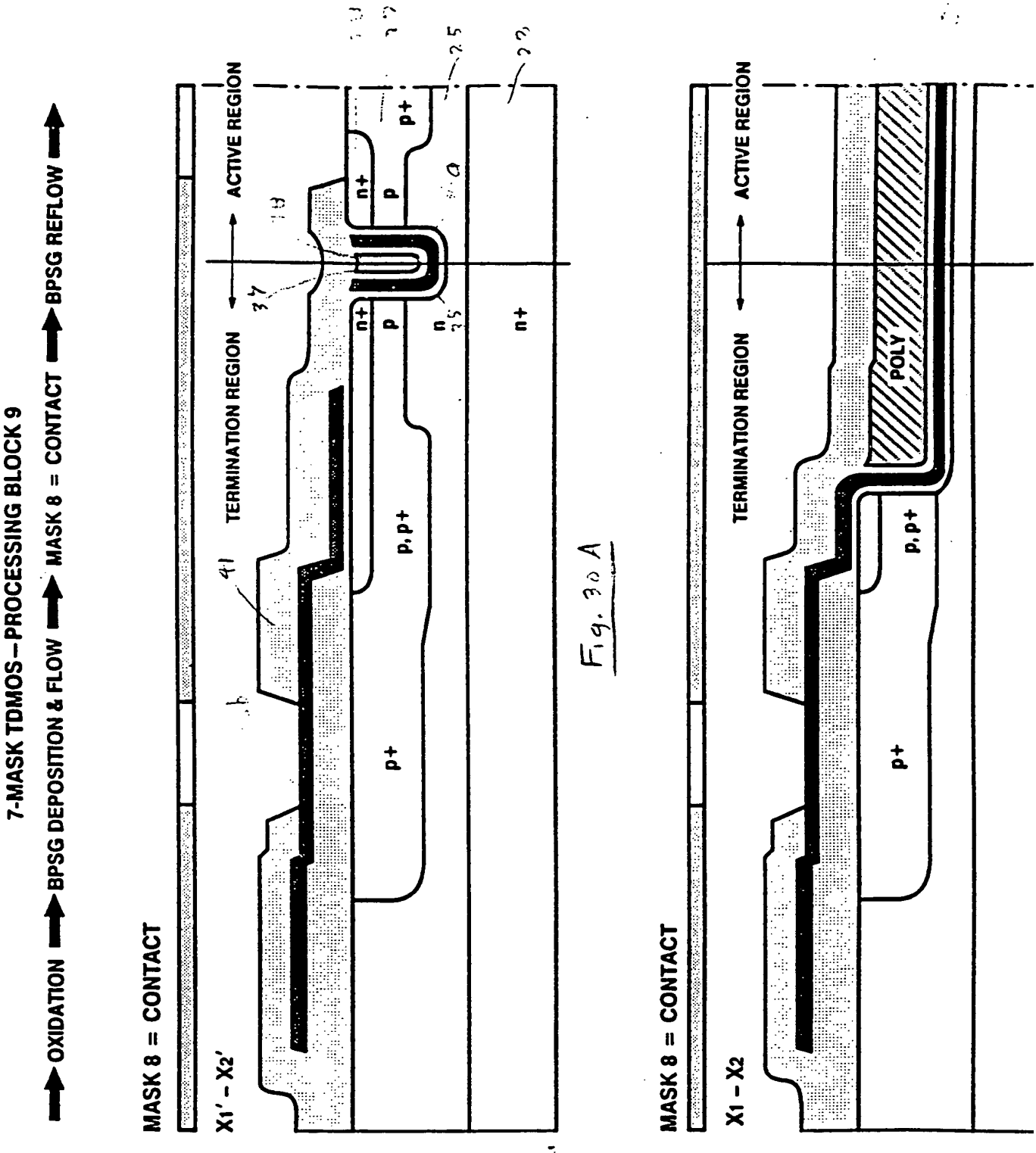


Fig. 30A

read & understood RKWills August 10, 1988
read and understood Randolph D. Lee August 11, 1988

7-MASK TDMOS – PROCESSING BLOCK 10

ALUMINUM DEPOSITION → MASK 8 = METAL → METAL ALLOYING → ELECTRICAL CHECK →

MASK 9 = METAL

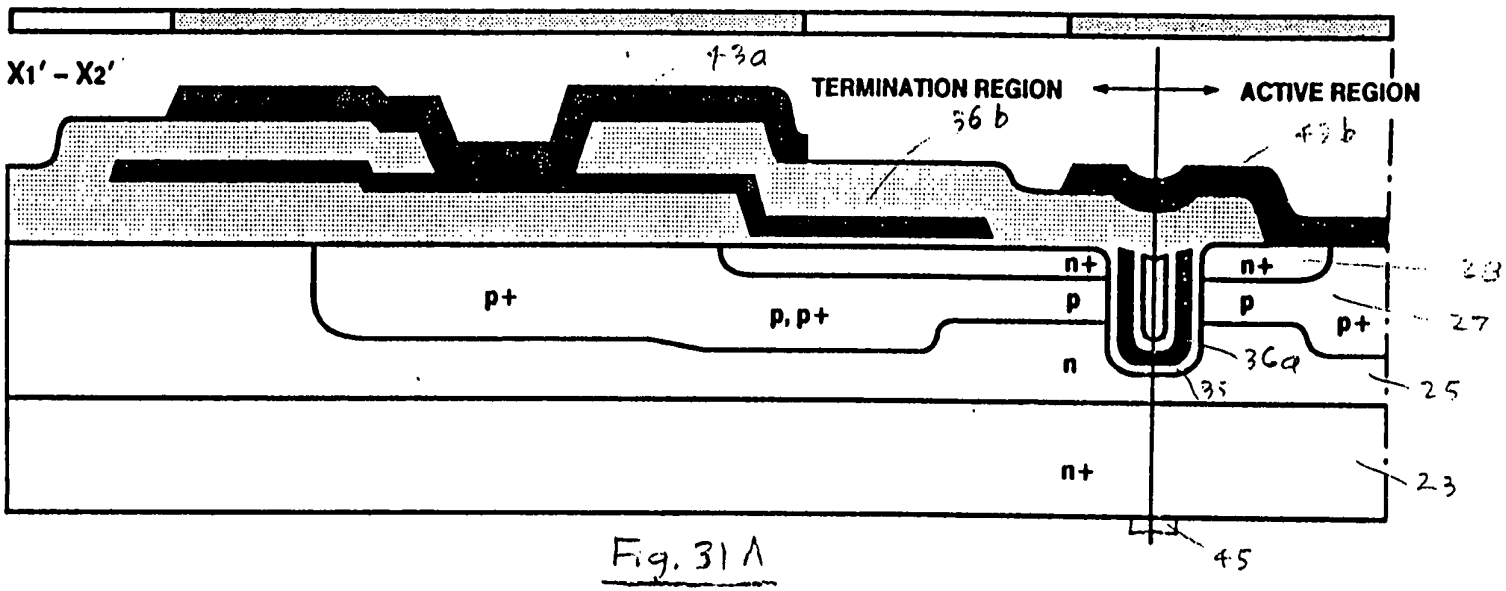
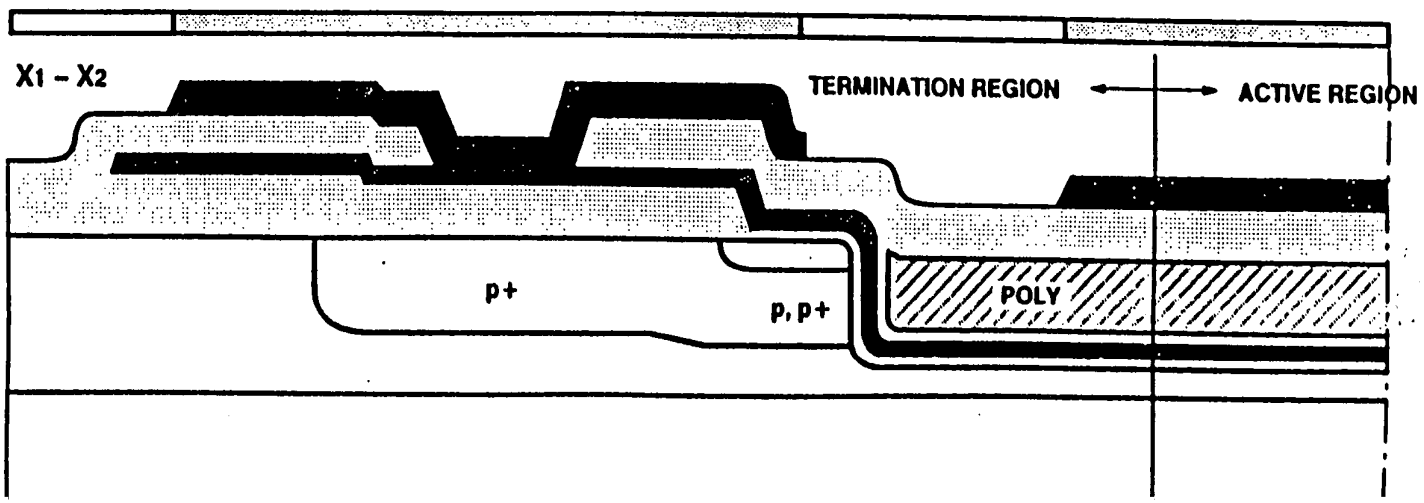


Fig. 31A

MASK 9 = METAL



read & understood GK WA August 10, 1988
and understood Raleigh RL August 4, 1988

08/869,760
#07/869,976

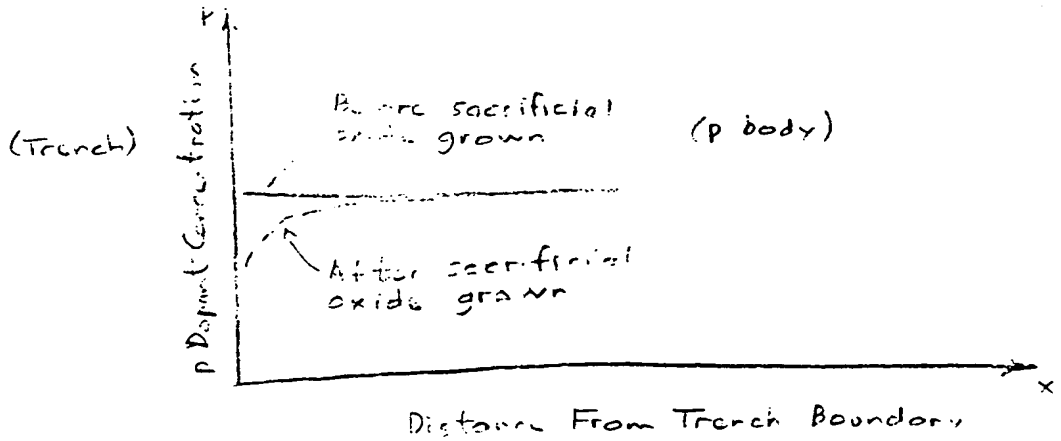


FIG. 32

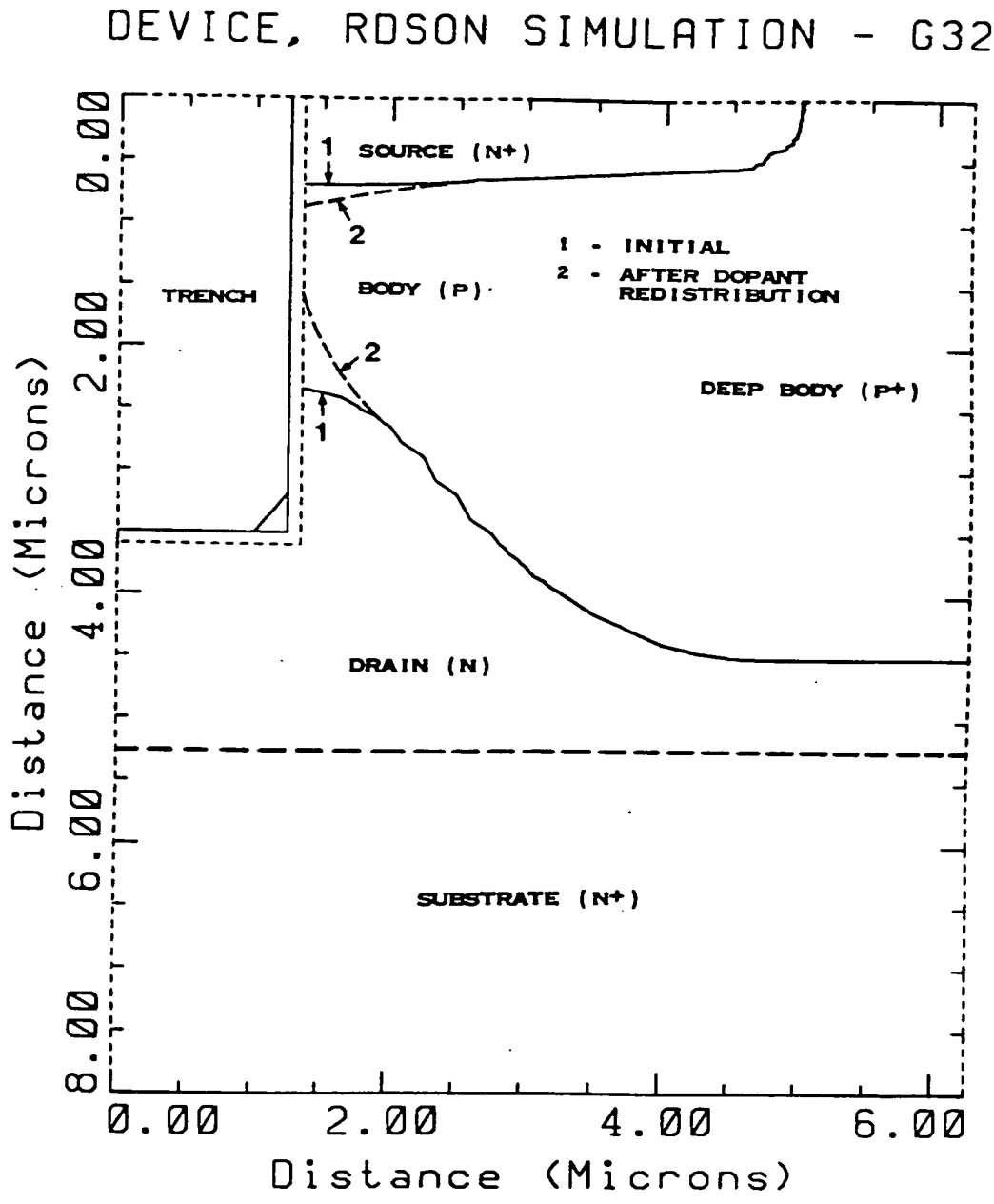

DEVICE, RDSON SIMULATION - G32
SOURCE (N+)
1 - INITIAL
2 - AFTER DOPANT REDISTRIBUTION
TRENCH
BODY (P)
DEEP BODY (P+)
DRAIN (N)
SUBSTRATE (N+)
Distance (Microns)
0.00
2.00
4.00
6.00
8.00
Distance (Microns)
0.00
2.00
4.00
6.00

FIG. 33

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